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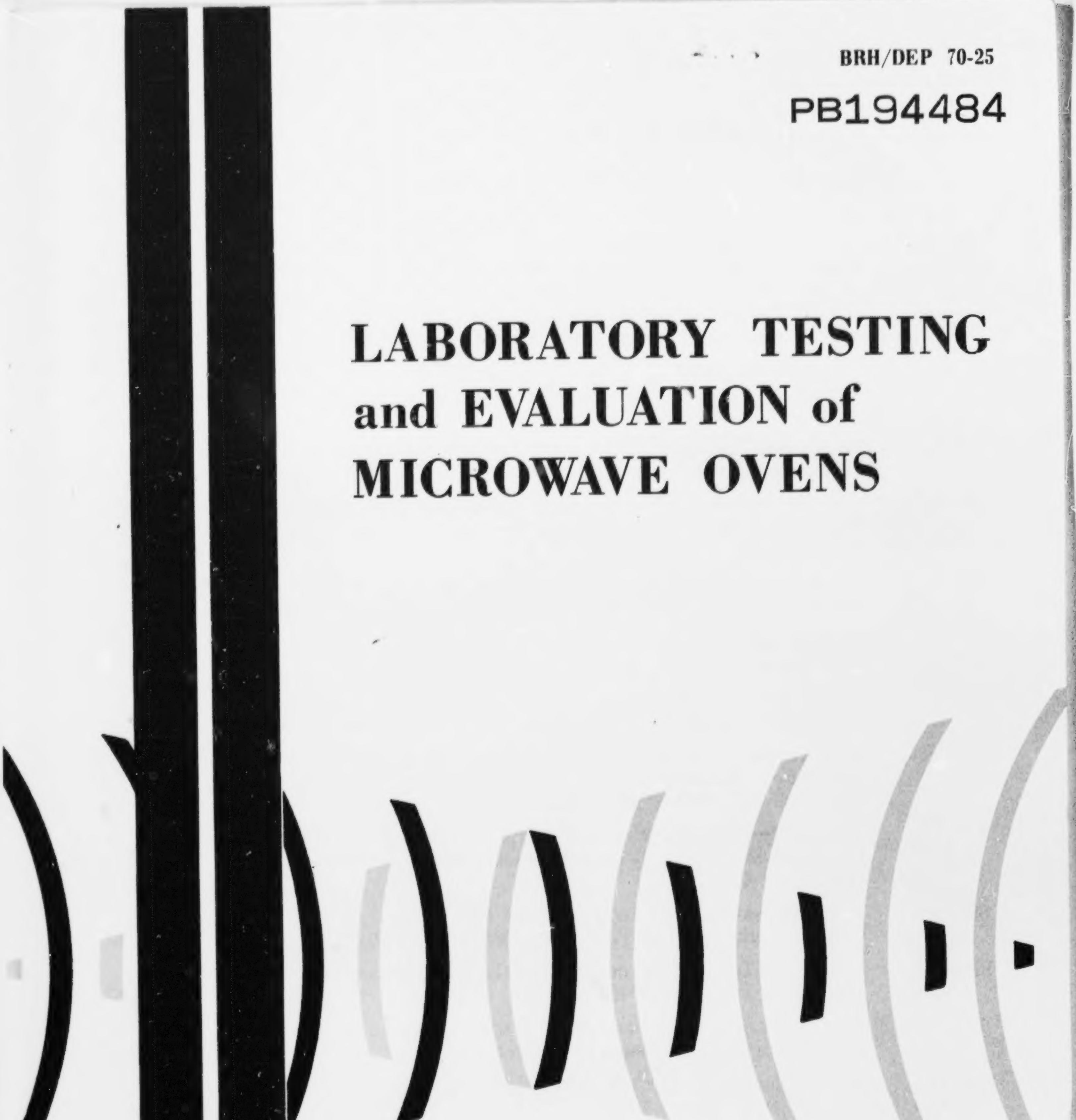

LABORATORY TESTING and EVALUATION of MICROWAVE OVENS

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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140

DIVISION OF ELECTRONIC PRODUCTS

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LABORATORY TESTING and EVALUATION of MICROWAVE OVENS

Stephen W. Smith, James W. Nicolls, Robert L. Moore, and Walter E. Gundaker
Product Testing and Evaluation Branch
Division of Electronic Products

October 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

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FOREWORD

The Bureau of Radiological Health, formerly the National Center for Radiological Health, continues to carry out a national program designed to reduce the exposure of man to hazardous ionizing and nonionizing radiation.

Within the Bureau, the Division of Electronic Products (1) develops and administers performance standards for radiation emissions from electronic products, (2) studies and evaluates emissions of and conditions of exposure to electronic product radiation and intense magnetic fields, (3) conducts or supports research, training, development, and inspections to control and minimize such hazards, and (4) tests and evaluates the effectiveness of procedures and techniques for minimizing such exposures.

The Bureau publishes its findings in Radiological Health Data and Reports (a monthly publication), Public Health Service numbered reports, appropriate scientific journals, and technical report series for the Bureau's divisions, offices, and laboratories.

The technical reports of the Division of Electronic Products (DEP) allow comprehensive and rapid publishing of the results of intramural and contractor projects. The reports are distributed to State and local radiological health program personnel, Bureau technical staff, Bureau advisory committee members, university radiation safety officers, libraries and information services, industry, hospitals, laboratories, schools, the press, and other interested individuals. These reports are also included in the collections of the Library of Congress and the Clearinghouse for Federal Scientific and Technical Information.

I encourage the readers of these reports to inform the Bureau of any omissions or errors. Your additional comments or requests for further information are also solicited.

John C Villforth

John C. Villforth
Director
Bureau of Radiological Health

PREFACE

Under the authority granted to the Secretary, Department of Health, Education, and Welfare by Public Law 90-602, the "Radiation Control for Health and Safety Act of 1968," the Bureau of Radiological Health is authorized, among other things, to prescribe a performance standard for microwave ovens controlling the microwave radiation leakage from such products. In order to provide background information about the characteristics of microwave ovens, the Division of Electronic Products has examined sample models of ovens from most manufacturers. Features of construction of each oven were studied, and measurements were made to determine the leakage levels of microwave radiation emitted by the ovens. The ovens were examined "as received" from the manufacturers. Some manufacturers have indicated that modifications have been made in other models. These models will be examined as part of a continuing testing program.

The manufacturers of commercial microwave ovens have been most cooperative throughout by providing technical information and making ovens available on loan. Their assistance is greatly appreciated.

Robert L Elder

Robert L. Elder, Sc.D.
Director
Division of Electronic Products

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AN EXAMINATION WAS MADE OF

ABSTRACT

The Division of Electronic Products has examined 14 microwave ovens from nine domestic and two foreign manufacturers. Twelve of the ovens are (or have been) available on the U.S. market, and two are prototypes not presently available. This THE report presents details of physical and electronic construction, technical specifications, and the microwave leakage levels determined for each oven.

LABORATORY TESTING AND EVALUATION OF MICROWAVE OVENS

1. INTRODUCTION

The measurement tests described in this report were performed to determine under laboratory conditions the levels of microwave radiation to which the user of a new microwave oven could be exposed when the oven was on and (1) the door was closed, (2) the door was in the process of being opened, and (3) the interlocks were defeated and the door was completely open. The tests were also performed in order to gather information in support of, and to determine the need for, a performance standard for microwave ovens.

The oven evaluations and tests covered by this report were conducted over a time interval from August 1968 to April 1970. Some changes in testing procedures have occurred over this time period as better instrumentation has become available and as more knowledge has been gained concerning important microwave oven characteristics. The information gathered in this report attempts to reflect the latest set of testing procedures. These testing procedures are presented in section 2. A list of safety requirements followed during the testing procedures is also presented in section 2.

The section on testing is organized so that each microwave oven description and evaluation is independent of the rest. This was done in order to separate the data according to oven manufacturer and model type without loss of meaningful information.

The information presented herein represents a summation of tests performed to date. Additional data will be obtained in the future and incorporated into reports that will be published as supplements to this document.

The technical specifications and wiring diagrams for the microwave ovens have been supplied by the manufacturer in almost all cases.

2. TESTING PROCEDURES

2.1 SPECIFICATION COMPILATION

At the time a microwave oven was received by the Product Testing and Evaluation Branch, the following items were recorded:

(1) Manufacturer

(2) Model

(3) Operating frequency (MHz)

(4) Magnetron manufacturer and model

(5) Magnetron characteristics (manufacturer's specifications)

(6) Line power requirements

(7) Type of cooling

(8) Inner dimensions of cavity

(9) Controls

(10) Viewing screen type

(11) Type of door seal

(12) Indications of microwave generator operation

2.2 DOOR SEAL EXAMINATION

Each oven was examined to determine the type of door seal used. The different door seals are described below.

2.2.1 Metal-Metal Pressure Door Seal

This type of door seal depends upon a metal-to-metal contact to cause the voltage gradient at the door edge to become zero. The effectiveness of such a seal in minimizing radiation depends upon the maintenance of a good contact between the pressure plate or metal mesh and cavity-door interface. Aging, denting, or grease accumulation on the metal seal can deteriorate the contact and lead to greater leakage radiation.

2.2.2 Capacitive Pressure Door Seal

A capacitive pressure door seal differs from a metal-to-metal seal in that it has a thin layer of dielectric material covering its contact plate. At microwave frequencies this capacitive plate performs in the same manner as the metal-to-metal seal. The dielectric coating increases the cavity-door interface breakdown potential, however, and thus reduces the possibility of arcing between the door and cavity.

2.2.3 Choke Door Seal

A choke seal works on the waveguide principle that a short circuit termination must have zero voltage and maximum current, while one-quarter wavelength away the current will be zero with the voltage at a maximum. With the current at zero at the door edge, the radiation is also zero so that no leakage is possible. Usually the quarterwave slot around the door is filled with some dielectric material so that food cannot get into the choke seal. This material can also effectively shorten the required slot in the door, since the material will generally have a dielectric constant different than that of air.

2.3 LEAKAGE MEASUREMENT PROCEDURES

The Narda 8100 and the procedure described in the Narda manual (see appendix A) was used to perform an initial survey under normal operating conditions. The distance of measurement was two inches (five centimeters) from the oven surface. Areas of concentration were the edge of the oven door and the edge of the viewing screen, if such existed on the oven. The location of the maximum reading and the reading itself (in mW/cm^2) were recorded along with all readings and their locations which were over 1 mW/cm^2. The highest reading and its location were also recorded for the situation in which the door was in the process of being opened quickly. The meter response was on the fast setting.

A leakage situation was simulated by covering the entire inside surface area of the door with one thickness (0.004 inch) of polyethylene plastic and following the procedure described above for the initial survey. The test was designed to simulate a coating of nonconductive substance that may occur under normal oven operating conditions.

The above tests were made with a load in the center of the cavity located on the lowest shelf position. Early tests were performed with a load of 250 ml of water in a 600-ml beaker, while the later tests were performed with 275 ml of water in a 600-ml beaker.

The power density was also recorded at 30 cm from the front cavity surface with the door fully open, the interlocks defeated, and the oven in operation. Prior to January 1969, Method 1, described below, was used to determine this power density. Since January 1969, Method 2 has been used. The two procedures are as follows:

Method 1: The oven was placed in an anechoic chamber with the oven opening about 14 feet from the chamber opening. The door interlocks were defeated, and arrangements were made to operate the oven remotely with the door open as far as possible. A load of 250 ml of water in a 250-ml beaker was placed in the center of the shelf in the oven cavity with the shelf in its lowest position. The power density measurements were made 30 centimeters from the front surface of the microwave cavity on the centerline. Power density readings were taken with a Ramcor 1200B Densiometer using any necessary attenuation and a method of external readout. This method and the power densities recorded have been reported in a previous Bureau of Radiological Health report.[1]

Method 2: The oven was placed in an anechoic chamber with the oven opening about 14 feet from the chamber opening. The door interlocks were defeated, and arrangements were made to operate the oven remotely with the door open as far as possible. A load of 250 ml or 275 ml of water in a 600-ml beaker was placed in the center of the shelf in the oven cavity with the shelf in its lowest position. The power density measurements were made 30 centimeters from the front surface of the microwave cavity on the centerline. A dipole antenna with a commercial power meter was used as the measuring instrument. The dipole was calibrated for several distances from a standard gain horn, and the two extremes for effective antenna area of the dipole were used to determine the power density.

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[1] Solem, D.L., D. C. Remark, R. L. Moore, R.E. Crawford, and H.J.L. Rechen. Report of Preliminary Measurements of Electromagnetic Radiation Fields Near Microwave Ovens. TSB No. 5. Bureau of Radiological Health, U.S.DHEW, December 1968. Available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151. Accession No. PB 185 967.

2.4 SAFETY INTERLOCK EVALUATION

In order to evaluate the microwave oven safety interlocks, the following items were compiled:

(1) Mechanical and electrical description of the interlocks (with schematic).

(2) Adjustments on each interlock.

(3) Door movement (in mm) from fully closed position to that at which each interlock turned off microwave power (as received).

(4) Distance oven door could open when interlock was adjusted for "worst case".

(5) Any other normal (manufacturer-designed) door or hinge adjustment.

(6) Steps necessary to operate oven with door fully open by simple mechanical manipulation from outside the oven.

> WARNING: Operation of a microwave oven with the door open is very dangerous and is not a recommended procedure for anyone to perform.

(7) Description of door latches.

(8) Suggested interlock improvements.

(9) Photographs of interlocks.

2.5 SAFETY PROCEDURES FOLLOWED DURING MICROWAVE OPERATIONS

Since the Bureau of Radiological Health is concerned with the elimination of potentially hazardous situations involving various types of radiation, it is mandatory that safety requirements be established and followed for work conducted within the Bureau. The following safety requirements were used in the microwave laboratories to ensure the safety of operating personnel.

No person was allowed to enter a radiating field where the power density was greater than 10 mW/cm^2. If it was necessary for a person to enter a field up to 10 mW/cm^2, it was ascertained that the power density at the eye was no greater than 1 mW/cm^2. Exposure times for the power density limits specified here were only long enough to conduct the required test. Tests were designed so that these exposure times were kept to a minimum.

At least two persons attended a test when it was known or suspected that the power density at any point in the radiating field would exceed 100 mW/cm^2. Any test involving a radiating field with a power density at any point greater than 10 mW/cm^2 was conducted in an anechoic chamber, and this chamber was constructed in such a way as to assure that the power density at any exit of the chamber would not exceed 1 mW/cm^2.

Warning signs were posted signifying the use of microwave equipment in the microwave laboratories, and any tests involving a radiating field with a power density greater than 1 mW/cm^2 at any point were signified by a red warning light near the entrance to the laboratory.

When situations not covered by the above safety requirements occurred, due caution was taken to ensure the safety of personnel.

These safety precautions required some knowledge of the radiating field prior to a test. Therefore, it was suggested that some calculations of possible power densities precede a test in order to estimate the conditions that would occur. If this could not be done, the test was run in one of the anechoic chambers, and extreme care was taken to assure that the safety requirements were met.

3. SUMMARY

A list of ovens tested during this project is presented in table 1. Table 2 is presented to provide a concise report of test results.

Most of the tests performed and the examinations described in this report were made prior to the first publication of the proposed standard for microwave ovens.[2] Many of the tests were made to gain background information for development of the standard, and several of the test methods were changed as better procedures were developed. As a result, the data presented herein were not necessarily taken in accordance with the procedures specified in the proposed standard. A comparison of the results with the proposed standard, therefore, would not be justified.

4. RECOMMENDATIONS

A suggested improvement for all microwave ovens is that a warning be delivered with the oven stating that a dangerous situation exists if the oven continues to "cook" with the door open and that the interlocks should not be adjusted or tampered with except by authorized personnel.

Several of the oven summaries presented in section 5 mention a viewing screen located on the door with no protective covering to prevent insertion of objects into the oven through the small holes. It should be mentioned that the insertion of an object through any of these small holes could be quite hazardous, especially if the object is metallic. A metallic object could act as receiving antenna in the cavity of an operating oven, while the other end could act as a transmitting antenna outside the oven. Such a situation can easily yield a power density of 200 mW/cm^2 outside the oven. Therefore, care must be taken to ensure that this situation does not occur.

---

[2] Proposed Performance Standard for Microwave Ovens. Federal Register, Vol. 35, No. 100, paragraph 78.212, pp. 7901-7902 (May 22, 1970).

Table 1. List of microwave ovens tested.

Brand name	Manufacturer	Model no.	Serial no.
International	International Crystal Manufacturing Co., Inc.	MC-24	884
International	International Crystal Manufacturing Co., Inc.	MC-24D	0912
Litton Industries	Litton Industries Atherton Division	500.015	24058
Litton Industries	Litton Industries Atherton Division	800	1319
Garland	Welbilt Corporation	EM-1	133308
Magic Chef®	Magic Chef, Inc.	MC-75.01	1674
Radarange®	Amana® Refrigeration, Inc.	RR-2	S18357883
Sears	Roper Corporation	103.9946700	7268160
Sears	Roper Corporation	103.9927001	9962750
Signature	Montgomery Ward Co., Inc. Electronics by Litton Industries	KTM8090	2169MK
Speedrange®	Omnivend	110D	2125
Tappan	Tappan	R-4A	04190-1828-2590
Toshiba	Tokyo Shibaura Electric Co., Ltd.	ER-602B	9080892
Versatronic™	General Electric	JE896E1	DEE00056

Table 2. Summary of microwave oven examinations and tests.

Brand name and model no.	No. of door interlocks	Maximum leakage levels (mW/cm^2)		Type of door seal	Viewing screen
		Door closed test	Door opening test		
International, MC-24	2	<1.0	10.0	Capacitive pressure	Yes
International, MC-24D	2	<1.0	1.0	Capacitive pressure	Yes
Litton Industries, 500.015	2	<1.0	<1.0	Capacitive pressure	Yes
Litton Industries, 800	3	2.0	-	Choke	Yes
Garland, EM-1	2	<1.0	<1.0	Metal-metal pressure	No
Magic Chef, MC-75.01	2	4.0	5.0	Capacitive pressure	Yes
Radarange, RR-2	3	<1.0	4.0	Choke	Yes
Sears, 103.9946700	2	<1.0	<1.0	Metal-metal pressure	Yes (protected)
Sears, 103.9927001	2	<1.0	<1.0	Metal-metal pressure	Yes
Signature, KTM8090	2	1.7	4.5	Choke	Yes (protected)
Speedrange, 110D	2	1.0	3.0	Choke	Yes
Tappan, R-4A	1	3.0	20.0	Metal-metal pressure	Yes
Toshiba, ER-602B	2	<1.0	3.5	Choke	Yes
Versatronic, JE896E1	2	2.0	-	Metal-metal pressure	No

Note: See text of report for details of tests.

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5. REPORT OF LABORATORY TESTS ON MICROWAVE OVENS

5.1 INTERNATIONAL CRYSTAL MODEL MC-24 OVEN

5.1.1 Summary

The International Crystal oven Model MC-24 is a countertop oven intended for domestic use. When the door is in the closed position, the oven is operated by an on-off switch and a rotary timer control. A ready light and a cooking light are provided on the oven to indicate the status of the oven.

When the oven was received by the Bureau of Radiological Health, two microswitches were employed to disrupt the microwave power when the door was being opened. A post protruding from the oven door simultaneously operated both microswitch lever arms. Interlock operation was dependent upon door motion. After examination and discussions with International Crystal personnel, a second interlock was received and installed on the oven. This second interlock is also a microswitch mounted on the left side of the oven behind the front panel and is operated by door movement.

The door is left hinged and opens greater than 90 degrees. When the door is closed and the oven is operating normally, a capacitive pressure door seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity through the back wall by means of a waveguide. A four-bladed stirrer is used for energy distribution; this stirrer operates at 48 revolutions per minute.

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5.1.2 Technical Specifications

Manufacturer: International Crystal

Model: MC-24

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Amperex Dx-206

Magnetron output power: 1000 W

Magnetron lifetime: 10 years or 10,000 on-offs

Magnetron current: 250 mA ± 10 percent

Line power requirements: 115 V a.c., 13 A

Type of generator cooling: Air

Inner cavity dimension: 11 inches by 11-3/4 inches by 8 inches

Controls: "On-off" switch, timer, "Ready" light, "Cooking" light

Viewing screen type: Metal mesh

Type of door seal: Capacitive pressure

Indicators of microwave generator operation: Two pilot lights on the front panel, a "ready" light, and a "cooking" light signify voltage being supplied to the magnetron. The magnetron is assumed operating when the ready light is on and the cooking light is on.

5.1.3 Safety Interlock Evaluation

5.1.3.1 Interlock in As-Received Oven

(1) Door interlock description: Two microswitches mounted behind a hole in a front panel. A post protruding from the oven door goes through the hole when the door closes and simultaneously operates both microswitch lever arms.

(2) Interlock adjustments: Switch position may be altered by moving the mounting bracket around in the oversized holes. Switch lever arms may be bent (but very stiff).

(3) Door movement for interlock operation: 2 mm

(4) Worst-case interlock adjustment: The door can open 7 mm before the oven shuts off.

(5) Other door or hinge adjustments: The hinge side of the door can be moved in and out within a 10-mm limit.

(6) Intentional interlock defeating technique: Any object up to 9 mm in diameter, when inserted through the front panel hole, will operate the interlocks, and the oven can then be operated with the door open.

(7) Door latch description: Two springs on the front panel hold the door closed.

(8) Suggested interlock improvement: Interlocks should be modified so that it is impossible to operate the oven with the door open by mechanical manipulation from the outside of the oven cabinet.

5.1.3.2 Additional Safety Interlock Provided by Manufacturers in May 1969

After initial examination by the Bureau of Radiological Health, a meeting, and correspondence between Bureau and International Crystal personnel, a second interlock was installed on the Model MC-24 oven. This interlock is described below.

(1) Door interlock description: One microswitch mounted on the left side of the oven behind the front panel is operated by door movement. The microswitch lever is operated by a piece of semi-rigid cable 8 cm long, one end of which is fastened to the top of the oven door near the hinge. The cable slides in and out through a hole in the front panel as the door opens and closes.

(2) Interlock adjustments: Switch position may be altered via mounting screws. Switch lever arm may be bent. Collar on end of cable which pushes switch lever arm may be moved in or out. Door may be moved in or out via hinge adjustment.

(3) Door movement for interlock operation: 35 mm.

(4) Worst-case interlock adjustment: With microswitch, door hinges, and collar adjusted for worst-case conditions, the door may be opened about 25 cm before the interlock shuts off.

(5) Other door or hinge adjustments: None

(6) Interlock defeating technique: The interlock cannot be defeated without loosening the machine screw which holds down one end of the interlock cable.

(7) Suggested interlock improvement: Fasten the cable to the oven door in a manner such that operation of the oven door will not loosen the holding screw.

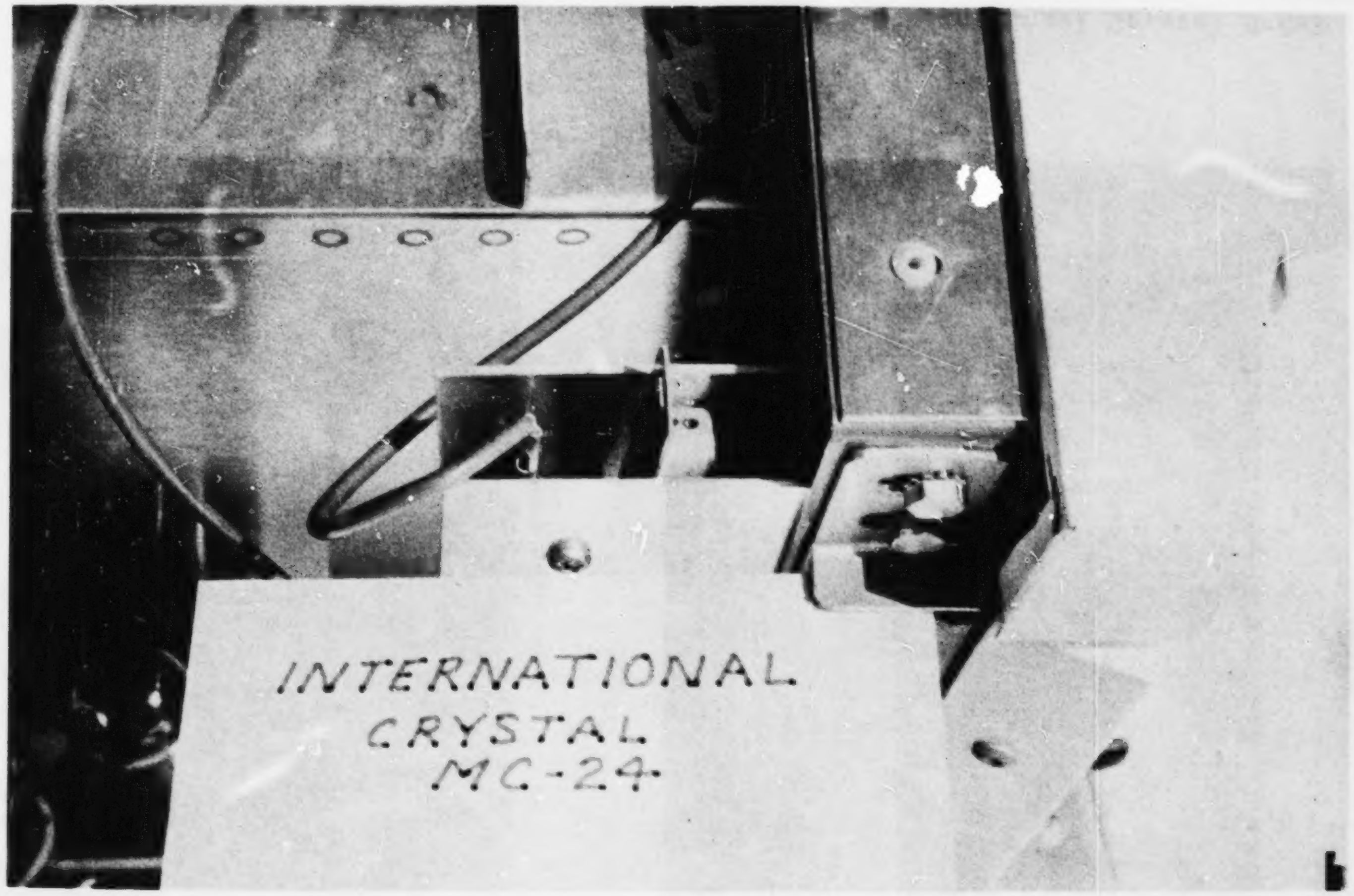

INTERNATIONAL
CRYSTAL
MC-24

Figure 1. International Crystal Model MC-24 additional safety interlock.

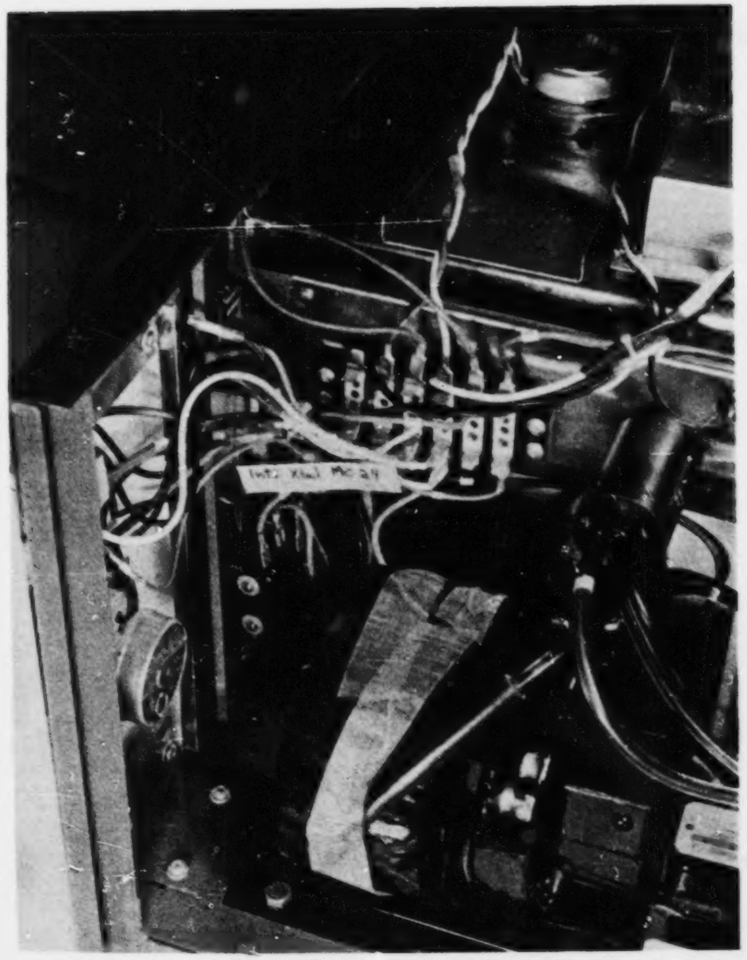

Int'l Xtal MC 24

Figure 2. International Crystal Model MC-24 back view.

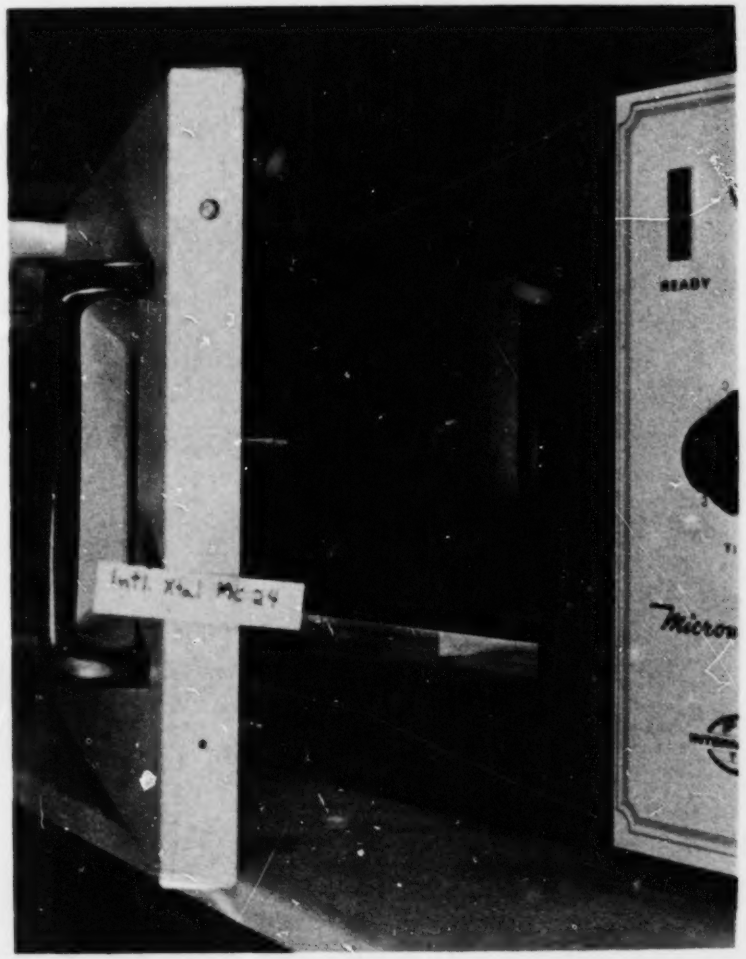

Int'l Xtal MC 24
READY

Figure 3. International Crystal Model MC-24 door interlock: two microswitches mounted behind a hole in front panel.

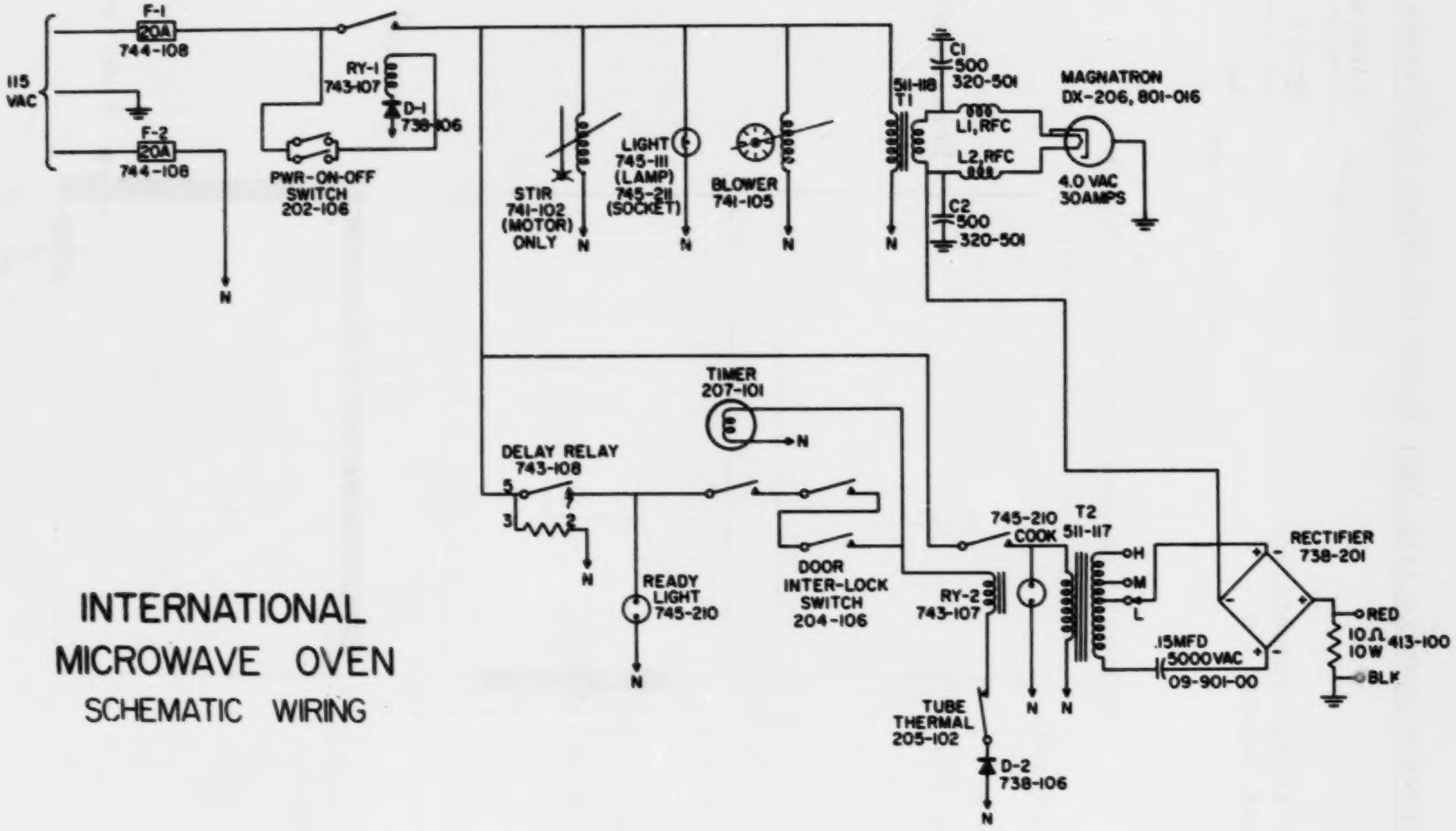

F-1
20A
744-108
115 VAC
F-2
20A
744-108
N
RY-1
743-107
D-1
738-106
PWR-ON-OFF SWITCH 202-106
STIR 741-102 (MOTOR) ONLY
N
LIGHT 745-111 (LAMP) 745-211 (SOCKET)
N
BLOWER 741-105
N
511-118
T1
N
C1
500
320-501
L1, RFC
L2, RFC
C2
500
320-501
MAGNATRON DX-206, 801-016
4.0 VAC 30AMPS
TIMER 207-101
N
DELAY RELAY 743-108
5
3
2
N
READY LIGHT 745-210
N
DOOR INTER-LOCK SWITCH 204-106
RY-2 743-107
745-210 COOK
T2 511-117
H
M
L
N
N
.15MFD 5000VAC
09-901-00
RECTIFIER 738-201
RED
10 Ω 10W 413-100
BLK
TUBE THERMAL 205-102
D-2 738-106
N
INTERNATIONAL
MICROWAVE OVEN
SCHEMATIC WIRING

Figure 4. Schematic of International Crystal Model MC-24.

5.1.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer International Crystal

Model MC-24

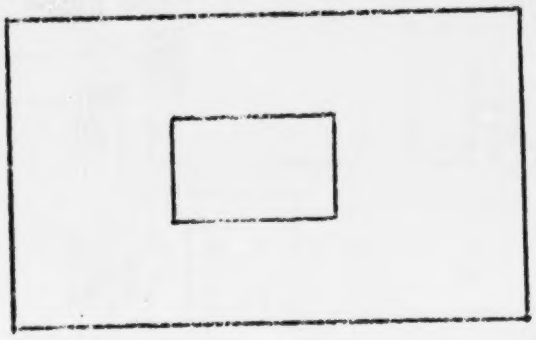
Serial Number 884

Key to instrumentation:
see appendix B

SCHEMATIC OF DOOR AND VIEWING SCREEN

(a) Without film

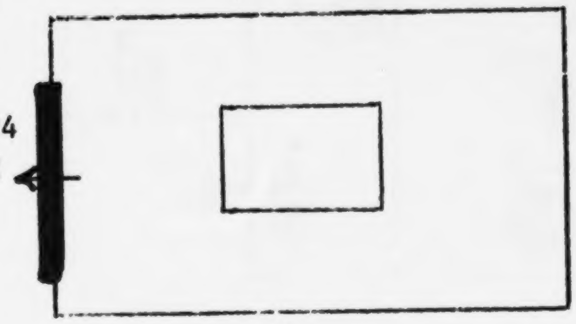
Meter #1
Probes #1, #4



Nothing above 1 mW/cm^2

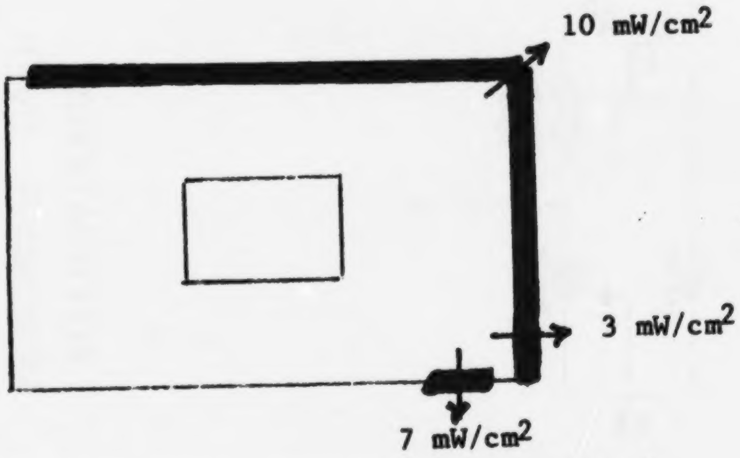
(b) With film

Meter #1
Probes #1,#4



(c) Door opening leakage

Meter #2
Probe #6



Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 259 mW/cm^2 - 750 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.2 INTERNATIONAL CRYSTAL MODEL MC-24D OVEN

5.2.1 Summary

The International Crytal oven Model MC-24D is an improved design of the MC-24 and is a countertop model intended for domestic use. When the door is closed, the microwave power is controlled by a rotary timer and an off button. A ready light and a cooking light indicate the oven status.

Two safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is a microswitch mounted behind a hole in the front panel. A stud protruding from the oven door activates this interlock and at the same time engages a spring-loaded catch. The second interlock is a microswitch mounted on the underside of the oven and is operated by a rod attached to the hinge side of the door. Both interlocks depend on door motion for operation.

The door is left hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a capacitive pressure door seal is used to eliminate leakage. A viewing screen is located on the door and has no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity through the upper back wall by means of a waveguide, and a stirrer is used for energy distribution.

5.2.2 Technical Specifications

Manufacturer: International Crystal

Model: MC-24D

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Amperex DX-206

Magnetron output power: 1000 W

Magnetron lifetime: 10 years or 10,000 on-offs

Magnetron current: 250 mA ± 10 percent

Line power requirements: 115 V a.c., 13 A

Type of generator cooling: Air

Inner cavity dimensions: 11 inches by 11-3/4 inches by 8 inches

Controls: "Off" button, timer, "Ready" light, "Cooking" light

Viewing screen type: Metal mesh

Type of door seal: Capacitive pressure seal

Indicators of microwave generator operation: Amber pilot light indicates microwave power is on.

5.2.3 Safety Interlock Evaluation

(1) Door interlock description:

(a) Door interlock A: A two-section single-pole double-throw microswitch mounted behind a hole in a front panel. A post protruding from the oven door goes through the hole when the door closes and pushes the switch to the second position. However, microwave power is activated as the switch is pushed to the first closed position.

(b) Door interlock B: A microswitch mounted on the underside of the oven and covered by a plate is closed by a rod attached to the hinge side of the door.

(2) Interlock adjustments:

(a) Door interlock A: The microswitch may be moved farther away from the door post through elongated mounting holes.

(b) Door interlock B: The entire microswitch can be moved to easier access or a less sensitive position without straining electrical connections by removing two screws. There are no normal adjustments.

(3) Door movement for interlock operation: The door interlock turns off oven before door opens. The secondary interlock turns oven off after the door has opened 30 mm.

(4) Worst-case interlock adjustment: Door interlock is normally in worst position. The secondary interlock can be moved so that door can open approximately 45 degrees while the oven is still operating.

(5) Other door or hinge adjustments: None

(6) Intentional interlock defeating technique: The door interlock can be defeated by pushing any thin rod such as a pencil or paper clip into the hole in the front panel. The secondary interlock under the cabinet of the oven can be defeated by taping or by moving the switch until it can be reached by hand.

(7) Door latch description: The door latch consists of a post to be pushed into a spring-loaded catch.

(8) Suggested interlock improvement: The secondary interlock should be mounted inside the cabinet so that it is not accessible.

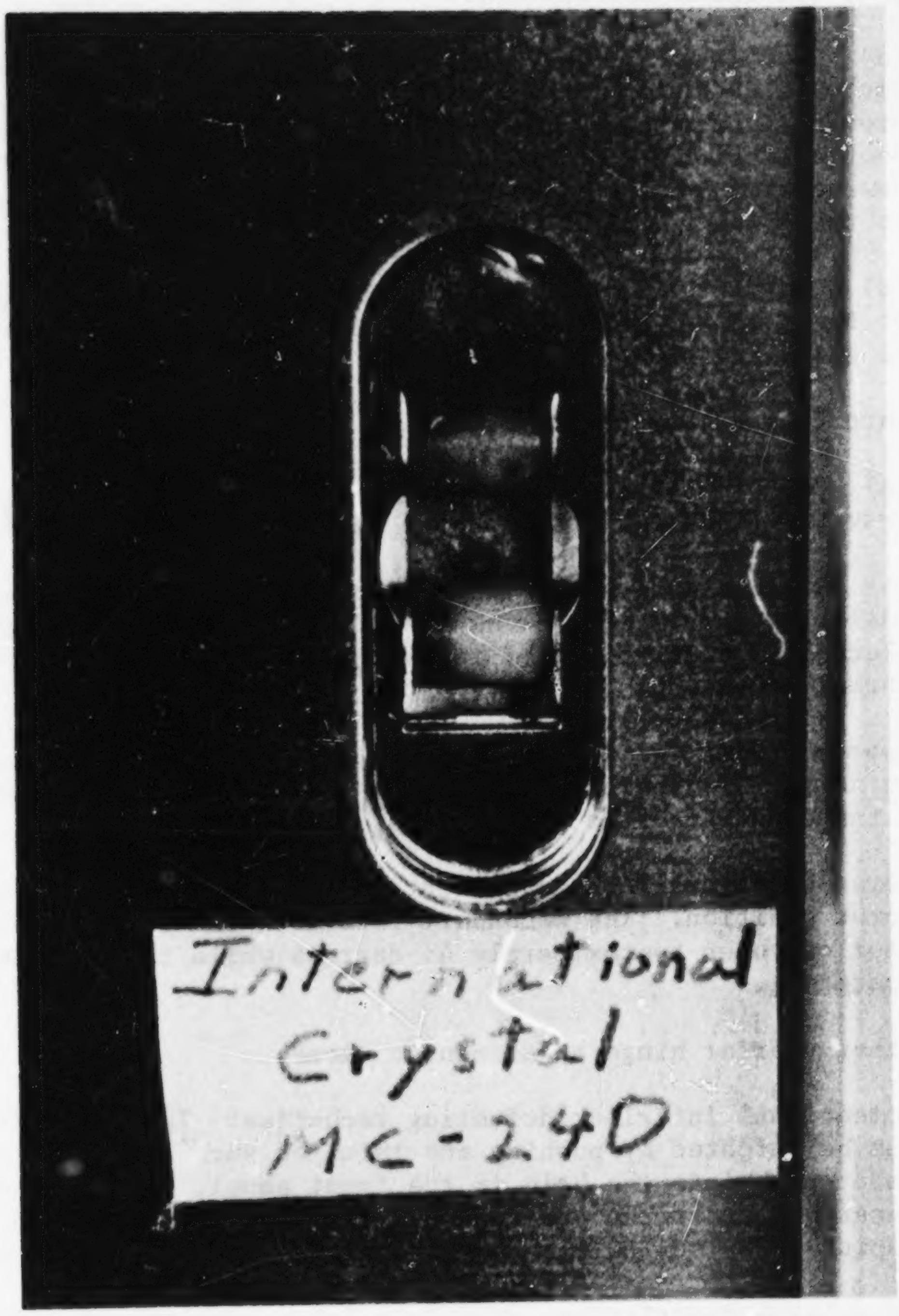

International
Crystal
MC-24D

Figure 5. International Crystal Model MC-24D door interlock mechanism.

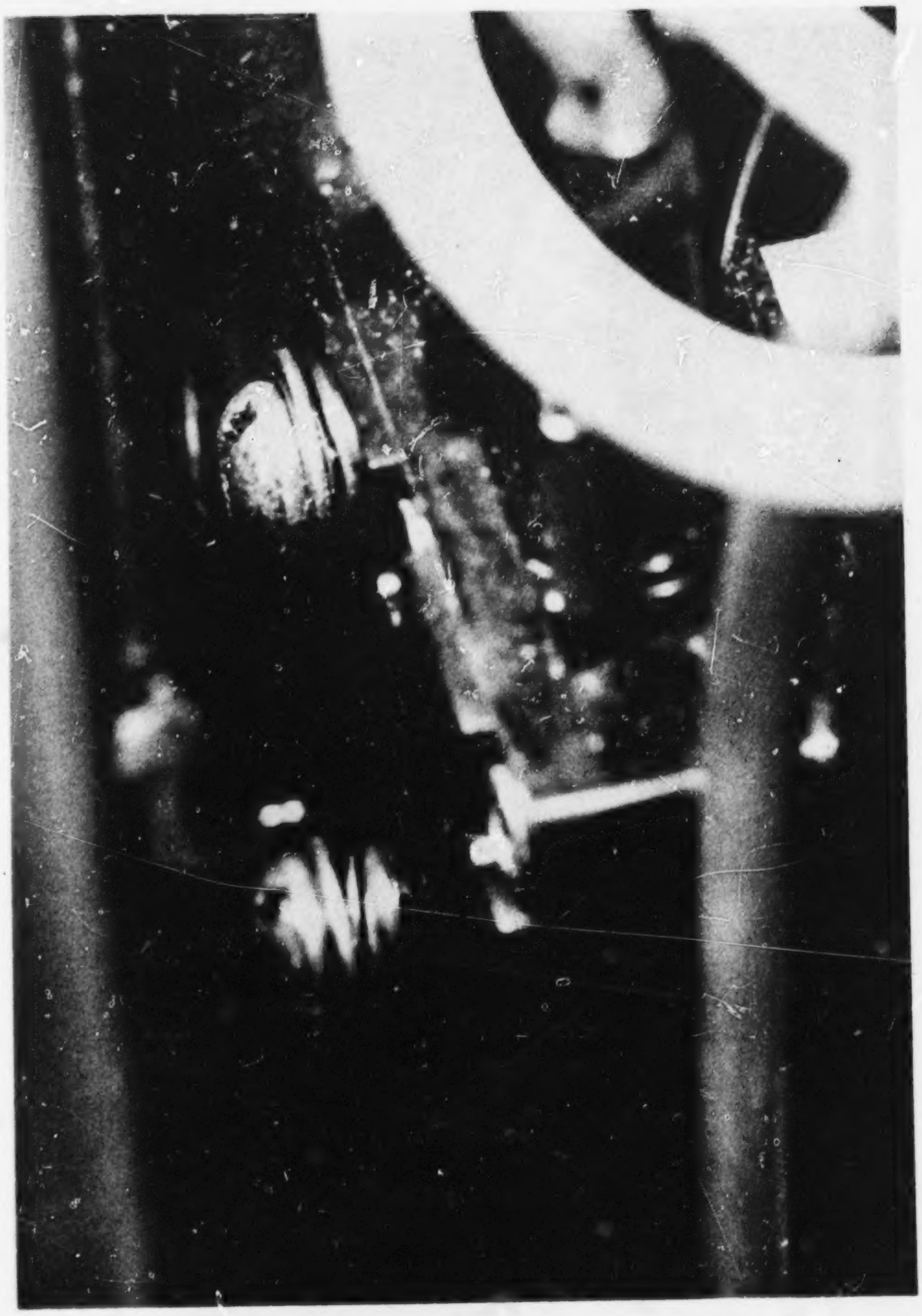


Figure 6. International Crystal Model MC-24D door interlock.

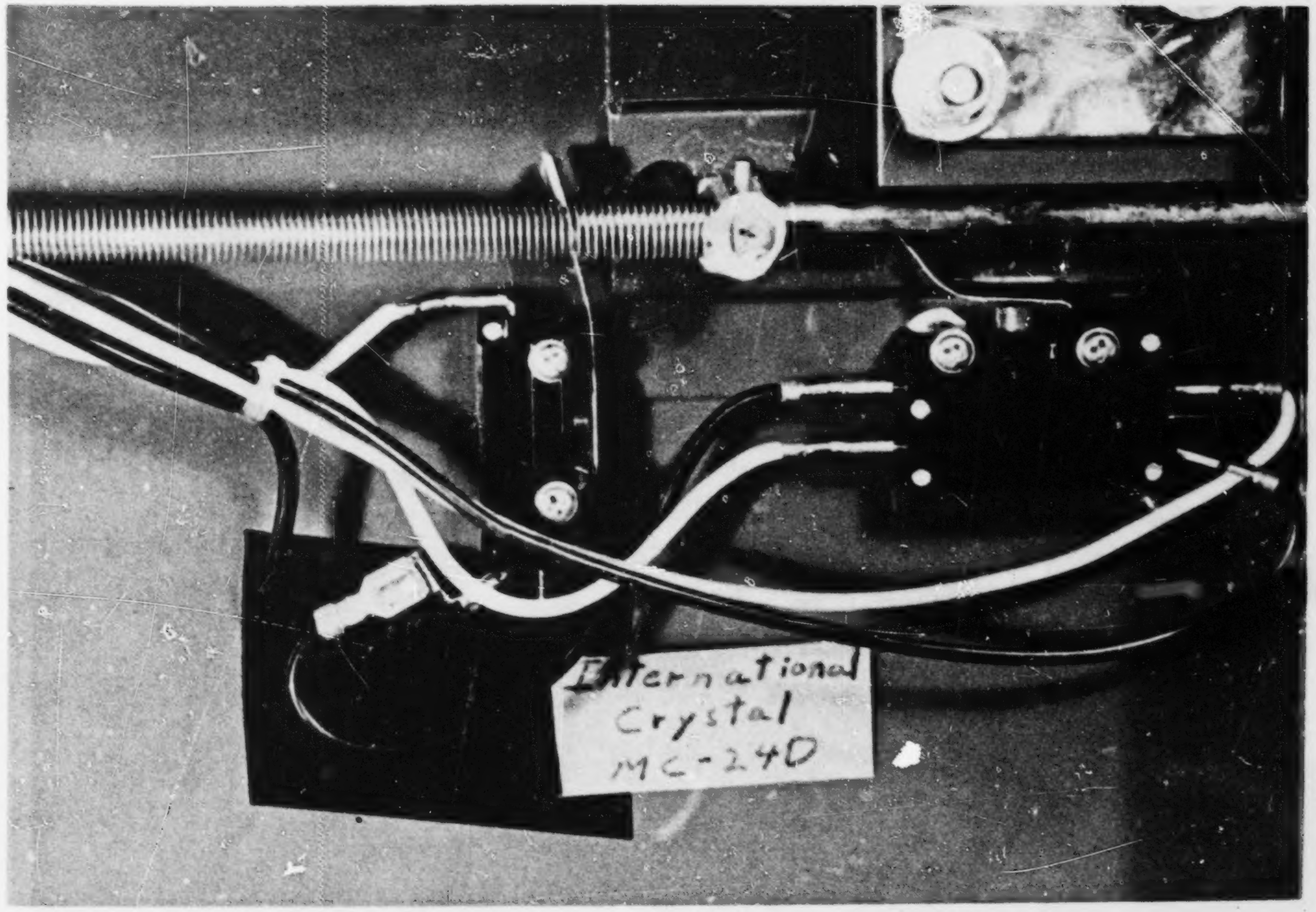

International
Crystal
MC-24D

Figure 7. International Crystal Model MC-24D interlock mounted on bottom of oven.

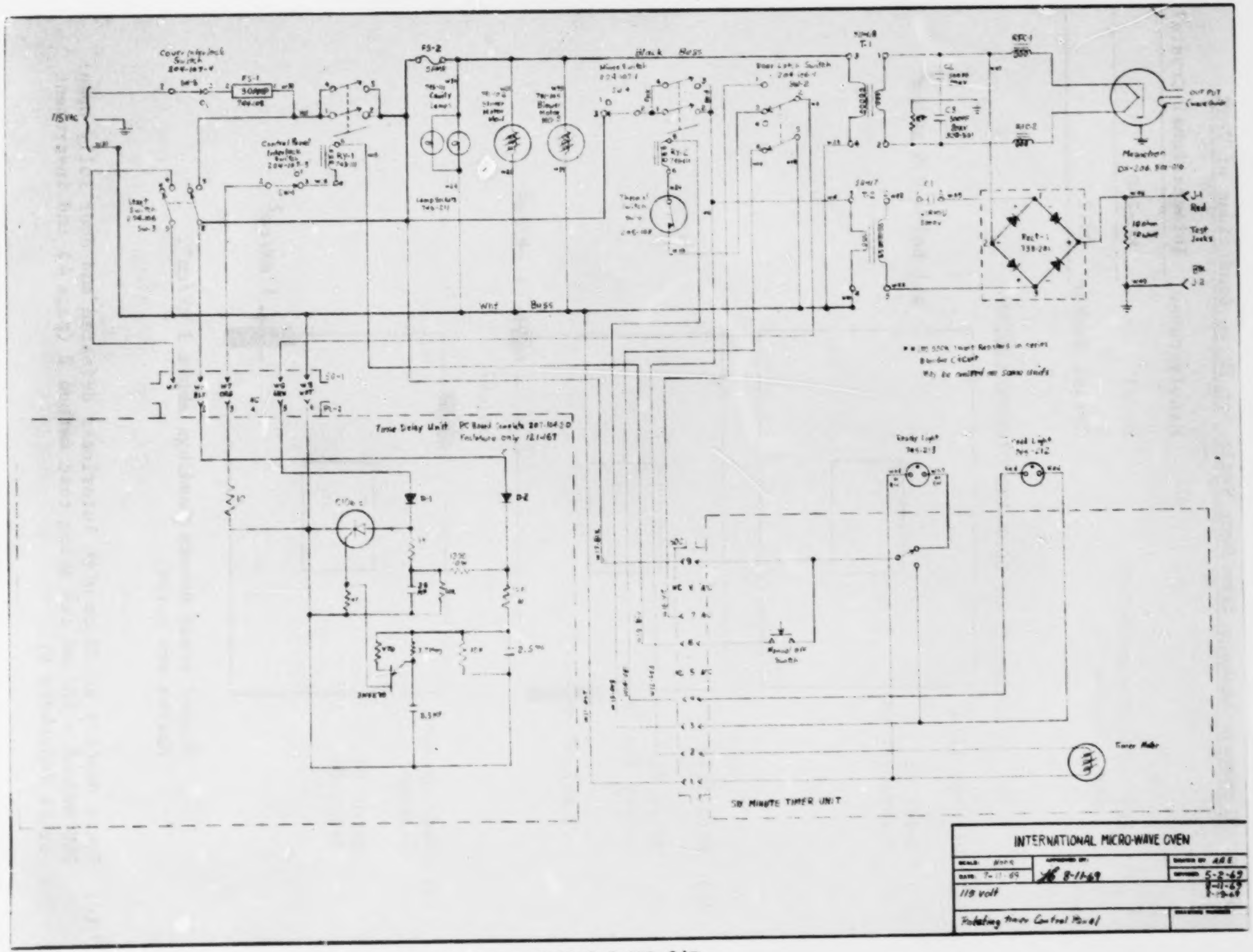

115VAC
Cover Interlock Switch 204-107-4
FS-1
30AMP
FS-2
5AMP
Cavity Lamps
Stirrer Motor
Blower Motor
Lamp Sockets 746-211
Control Panel Interlock Switch 204-107-3
RY-1
Start Switch
Black Buss
Wht Buss
Mixer Switch
RY-2
Thermal Switch
Door Latch Switch
T-1
T-2
RFC-1
RFC-2
C3
Magnetron
Output Coaxial Guide
Rect-1
J-1 Red
Test Jacks
J-2
Time Delay Unit
Ready Light
Cook Light
Manual Off Switch
Timer Motor
30 MINUTE TIMER UNIT
INTERNATIONAL MICRO-WAVE OVEN
None
7-11-69
8-11-69
115 volt
ARE
5-2-69
8-11-69
8-19-69
Rotating Timer Control Panel

Figure 8. Schematic of International Crystal Model MC-24D.

5.2.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer International Crystal

Model MC-24D

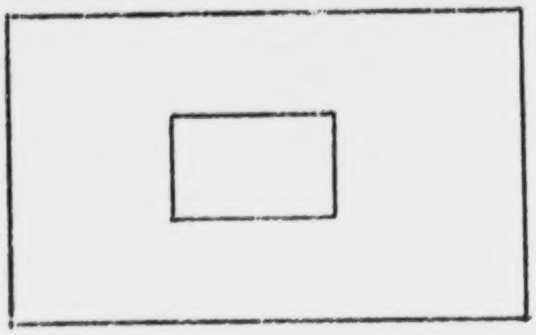
Serial Number 0912

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

(a) Without film

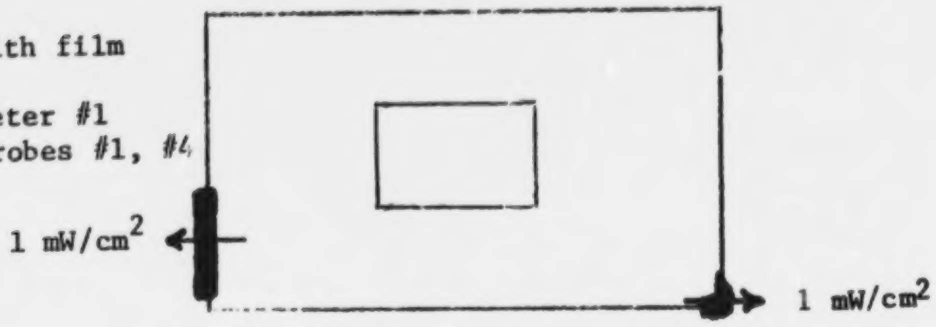
Meter #1
Probes #1, #4



All below 0.5 mW/cm^2

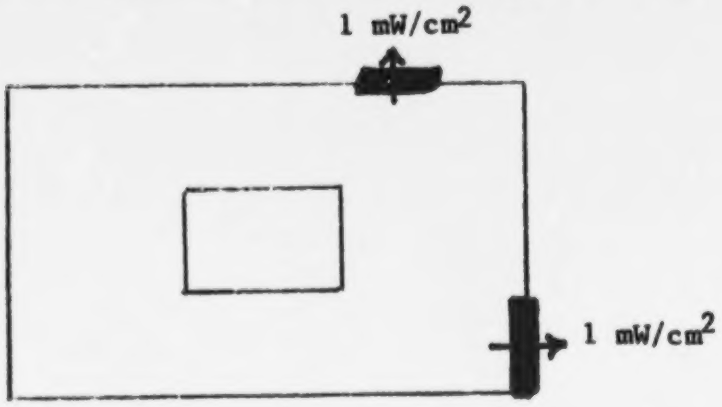
(b) With film

Meter #1
Probes #1, #4



(c) Door opening
leakage

Meter #2
Probe #6



Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 160 mW/cm^2 - 485 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.3 LITTON MODEL 500.015 OVEN

5.3.1 Summary

The Litton Model 500.015 microwave oven is mainly a commercial oven, but use in the home is also possible. When the door is in the closed position, operation is controlled by a power on-off switch and six pushbutton timer switches. A ready light and a cooking light indicate the oven status.

Two interlocks are employed to disrupt microwave power when the door is opened. One microswitch is mounted near the front panel of the oven and is operated by a post protruding from the oven door which goes through a small hole in the panel when the door is closed. The second interlock is a microswitch mounted along the left lower side of the oven. The switch lever arm is moved by a curved arm fastened to the door. Both interlocks depend on door motion for operation. A door latch is used to hold the door in the closed position. The operating cycle of this oven helps to prevent interlock defeat, since a certain procedure of door motion must be simulated in order to defeat the interlocks. This is an added safety feature.

The door is left hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a capacitive pressure door seal is used to eliminate leakage. A viewing screen is located on the door and has no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity through the top of the oven by means of a waveguide, and a stirrer is used to distribute the microwave energy. The stirrer operates at 20 revolutions per minute.

5.3.2 Technical Specifications

Manufacturer: Litton

Model: 500.015

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L5001

Magnetron output power: 1000 W

Magnetron lifetime: 2000 to 3000 hours

Magnetron current: 540 mA

Line power requirements: 110 to 125 V a.c.

Type of generator cooling: Air

Inner cavity dimensions: 12 inches by 5-7/16 inches by 12-1/2 inches

Controls: "Ready" light, "Cooking" light, six-pushbutton timer

Viewing screen type: Metal grid

Type of door seal: Capacitive pressure seal

Indicators of microwave generator operation: Ready light and cooking light

5.3.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Cabinet interlock: One microswitch mounted at the back of the chassis; microswitch plunger directly operated by contacting the cabinet wall.

(b) Door interlock "A": Microswitch mounted near the front panel of the oven and operated by a post fastened to the oven door which goes through a small hole in the panel when the door is closed. The post pushes against the microswitch plunger.

(c) Door interlock "B": Microswitch mounted in the side of the oven. The switch plunger is operated by a metal lever which is moved by a curved arm fastened to the door. When the door is closed, the curved arm contacts the lever and operates the switch.

(d) A timer panel interlock is mounted adjacent to the door interlock A.

(2) Interlock adjustments:

(a) Cabinet interlock: None

(b) Door interlock A: None

(c) Door interlock B: Microswitch mounting bracket may be moved 6 mm in the direction of lever motion.

(3) Door movement for interlock operation:

(a) Door interlock A turns off the oven after the door has opened 1 mm.

(b) Door interlock B turns off the oven after the door has opened 6 mm.

(4) Worst-case interlock adjustment: Door interlock B: 11 mm.

(5) Other door or hinge adjustments: Hinges may be shimmed (would not affect door interlocks).

(6) Intentional interlock defeating technique: The oven cannot be operated with the door open without first jamming door interlock A through the panel hole and operating interlock B by unfastening the curved arm from the oven door and fastening it into the position assumed when the door is closed.

(7) Door latch description: A mechanical latch provides positive closure.

(8) Suggested interlock improvements: An interlock system should be fitted into the door latch rather than based on door movement.

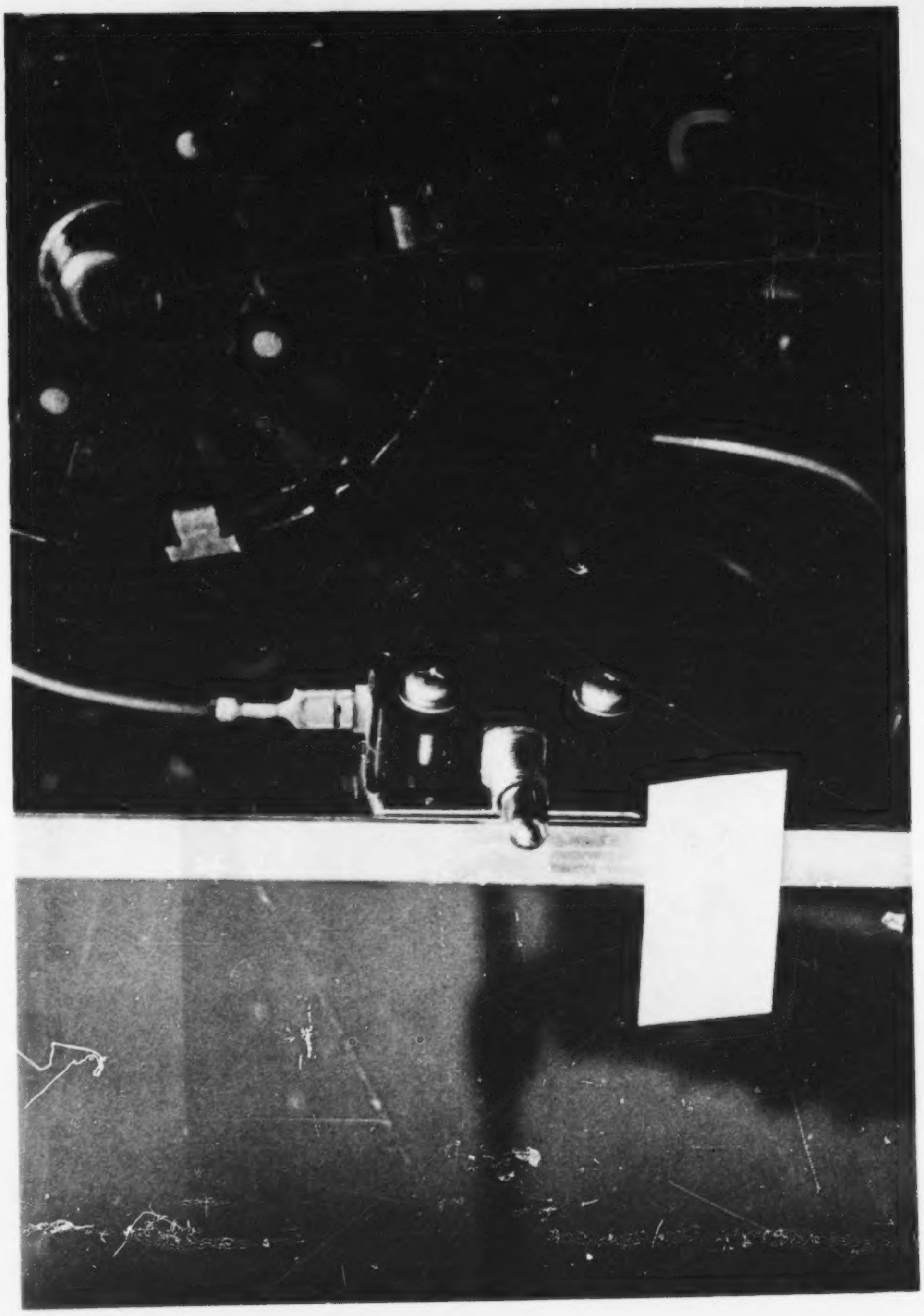


Figure 9. Litton Model 500.015 cabinet interlock mounted in rear of oven.

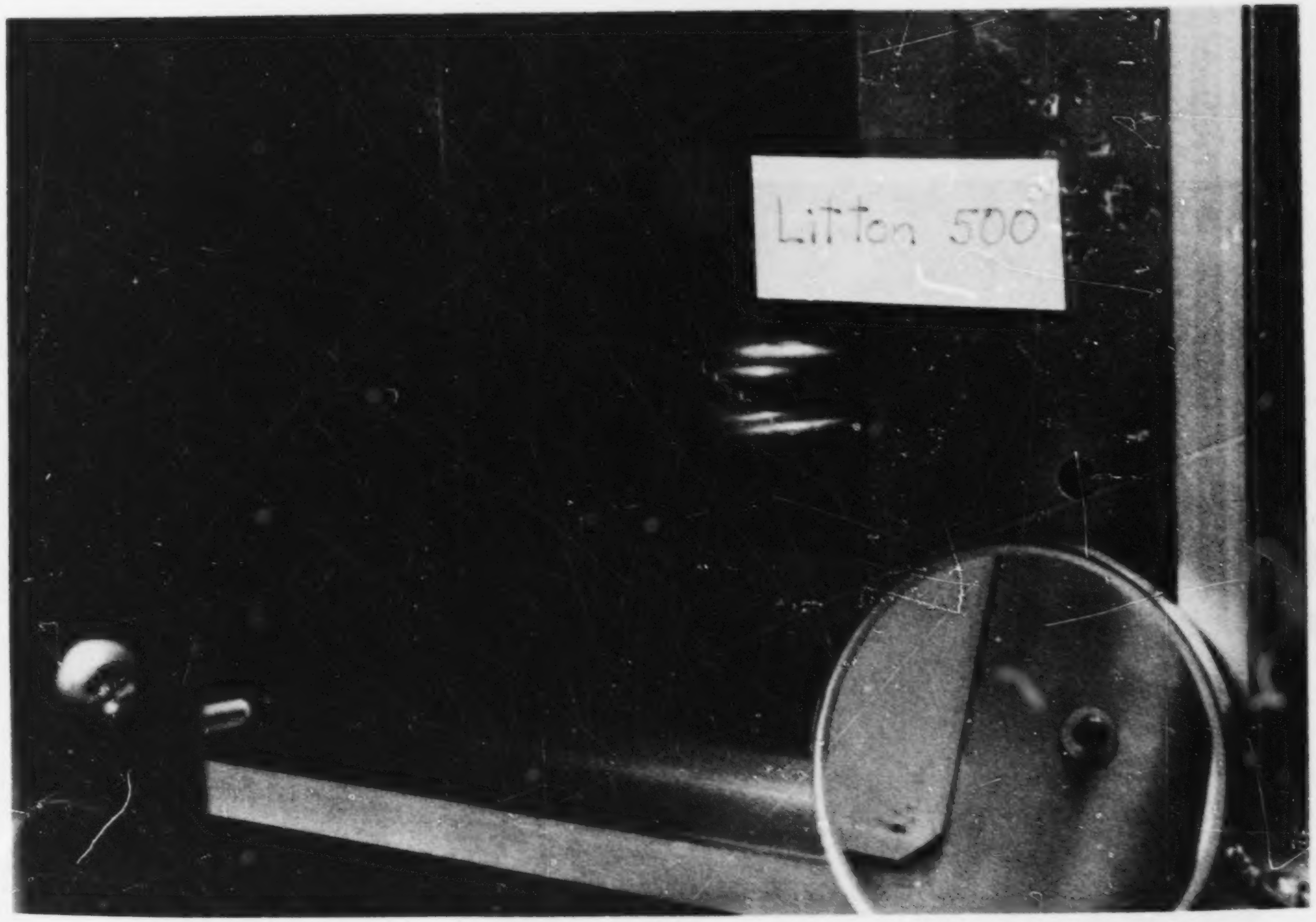


Figure 10. Litton Model 500.015 door interlock A mounted on front panel.

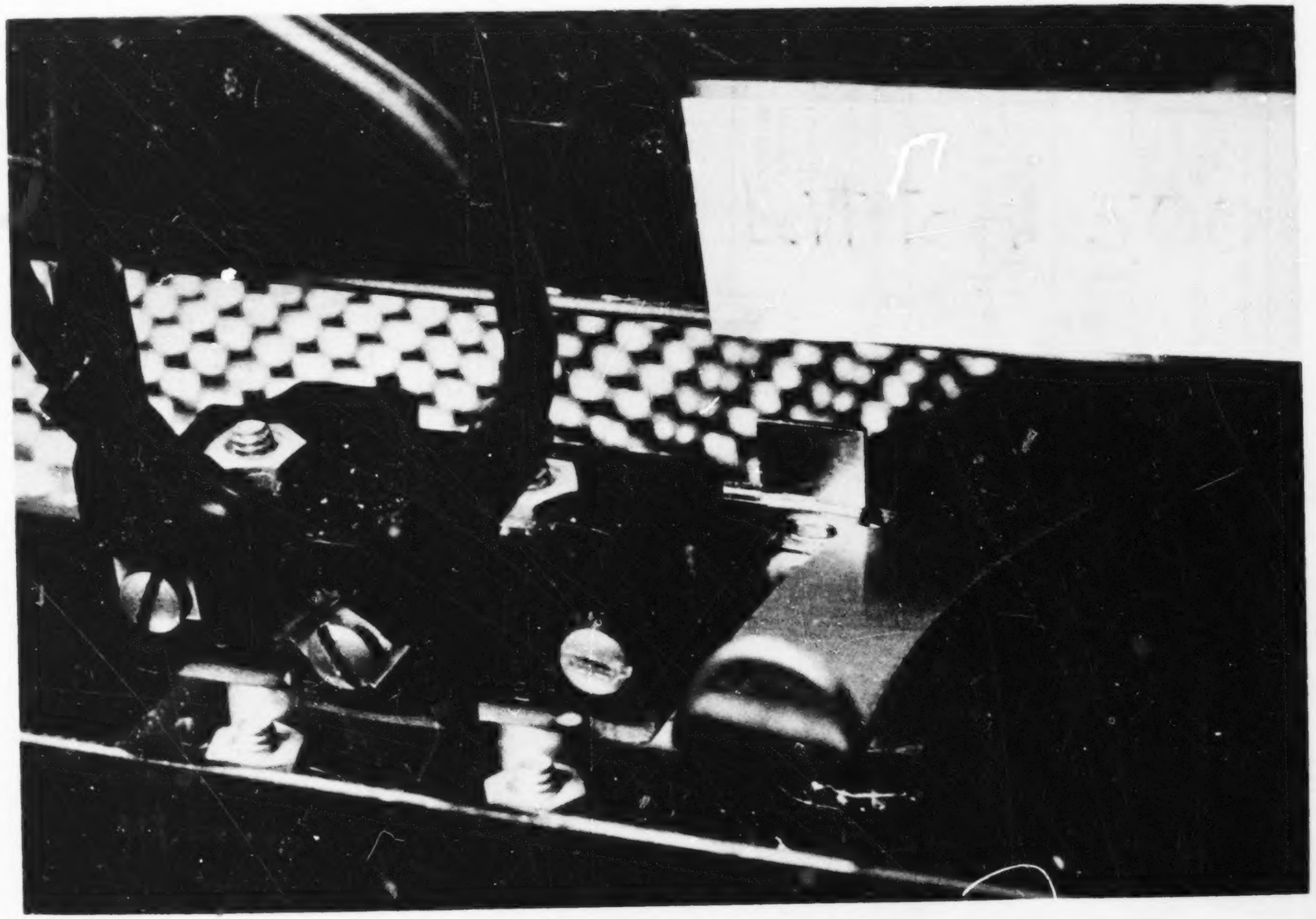


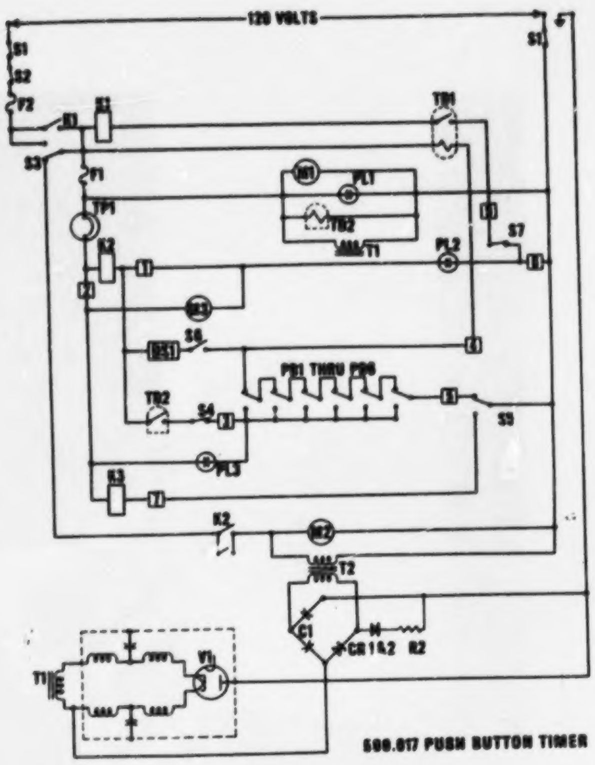
Figure 11. Litton Model 500.015 door interlock B mounted on side of oven.

NOTE

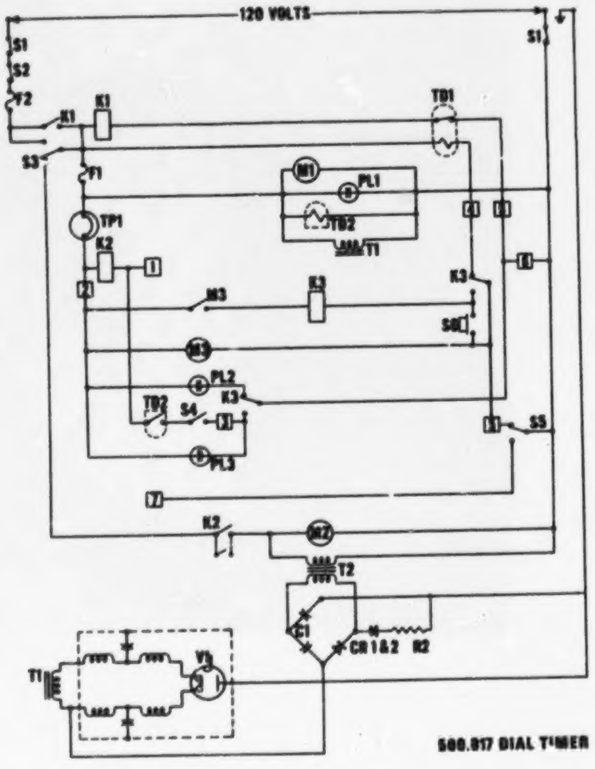
The manufacturer has stated that the schematic for the Model 500.017 oven (shown here) is identical to that of the Model 500.015 which was tested.

LEGEND

S1	Main On/Off S/W
S2	Timer Panel Interlock S/W
S3	Left Door S/W
S4	Rear Cover Interlock S/W
S5	Right Door S/W
S6	Timer Buzzer S/W-PB Push to Cook S/W Dial
S7	Timer Safety S/W-PB
F1	3 amp Fuse Slow Blow
F2	20 amp Fuse
TD1	Auto/Shutdown Relay
TD2	10/sec. Warm Up Relay
M1	Blower Motor
M2	Stirrer Motor
M3	Timer Motor
PL1	Cavity Light
PL2	Ready Light
PL3	Cook Light
T1	Filament Trans.
T2	Plate Trans.
CR1-2	Diode
C1	Capacitor
V1	Magnetron
K1	Start Up Relay
K2	Cook Relay
K3	Timer Relay
R2	Plate Load Resistor


120 VOLTS
S1
S2
F2
S3
K1
F1
TP1
TD1
M1
PL1
TD2
T1
PL2
S7
K2
M3
S6
PB1 THRU PB6
TD2
S4
S3
PL3
K3
K2
M2
T2
C1
CR1&2
R2
T1
V1

500.017 PUSH BUTTON TIMER


120 VOLTS
S1
S2
F2
K1
S3
F1
TD1
M1
PL1
TD2
T1
TP1
K2
M3
K3
S6
PL2
TD2
S4
S5
PL3
K2
M2
T2
C1
CR1&2
R2
T1
V1

500.017 DIAL TIMER

Figure 12. Schematic of Litton Model 500.017.

5.3.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Litton

Model 500.015

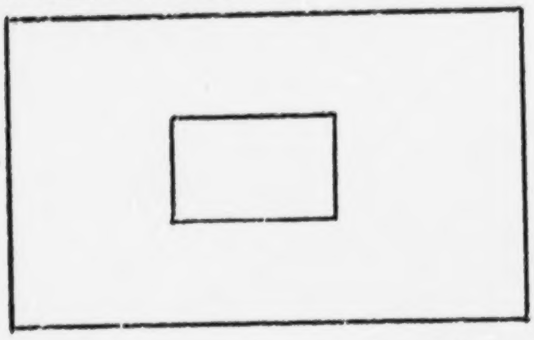
Serial Number 24058

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

(a) Without film

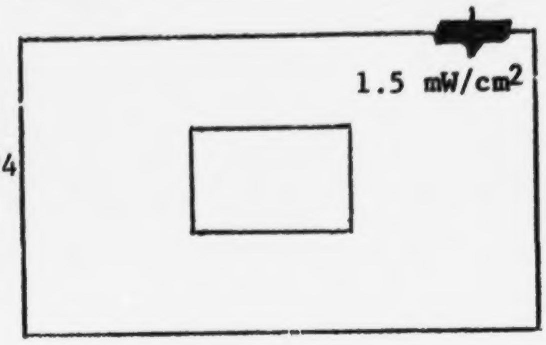
Meter #1
Probes #1, #4



Less than 0.5 mW/cm^2

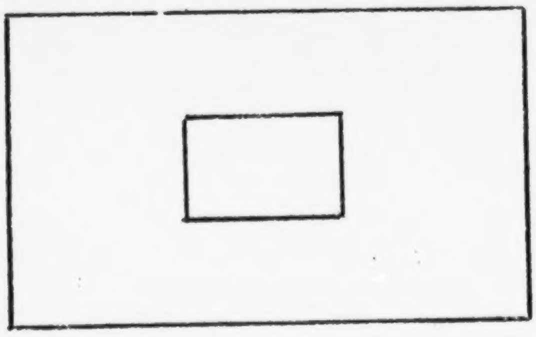
(b) With film

Meter #1
Probes #1, #4



(c) Door opening leakage

Meter #2
Probe #6



Less than 0.5 mW/cm^2

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 540 mW/cm^2 - 850 mW/cm^2 using test method 1 (page 4) and instrument set #2 (appendix B).

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5.4 LITTON MODEL 800 OVEN

5.4.1 Summary

The Litton Model 800 microwave oven is a commercial oven with twice the output power of the Litton Model 500. The oven is essentially two Litton Model 500s arranged on the same chassis, in parallel, so that either one or both of the units can be operated at any time. When the door is in the closed position, the microwave power is operated by a power on-off switch, a rotary dial on-off switch, a rotary timer control, a high or low power rotary switch, and a start button. Ready and cooking lights are provided to tell the oven status.

Three safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is a microswitch mounted behind the panel and operated by the catch mechanism on the door pushing the microswitch level arm. This interlock is dependent on the door latch motion and not on the motion of the door itself. The two other interlocks are microswitches mounted on one side of the oven about one foot behind the front panel. The lever arms are operated by a metal extension of the door. The operating cycle of this oven helps to prevent interlock defeat, since a certain procedure of door motion must be simulated in order to defeat the interlocks. This is an added safety factor.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a choke door seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity through the top of the oven by waveguide and distributed by two rotating slotted metal plates. These plates rotate at 10 revolutions per minute, and this rotation creates a more even energy distribution within the cavity.

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5.4.2 Technical Specifications

Manufacturer: Litton

Model: 800

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L5001 (two)

Magnetron output power: High power-2000 W; Low power-1000 W

Magnetron lifetime: 2000 to 3000 hours each

Magnetron current: 600 to 650 mA each

Line power requirements: 205/250 V a.c., 2-wire, single phase

Type of generator cooling: Air

Inner cavity dimensions: 24 inches by 14 inches by 10 inches

Controls: On-off dial, "Ready" light, "Cooking" light, "Start" button, dial timer

Viewing screen type: Metal grid

Type of door seal: Choke door seal

Indicators of microwave generator operation: Two sets of pilot lamps on the front panel, a "ready" light and a "cooking" light, indicate filament and anode voltages are applied to the magnetrons when the "cooking" light is on and the "ready" light is off.

5.4.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Cabinet interlock: One microswitch mounted at back of oven chassis; microswitch plunger directly contacts cabinet back.

(b) Door interlock A: Microswitch mounted on door latch behind front panel; operated by the catch mechanism on door pushing the metal strip of the interlock. Latch must be released before the door is opened.

(c) Door interlocks B and C: Two microswitches mounted on one side of the oven about one foot behind the front panel. The switch lever arms are operated by the oven door opening limiter arm when the door is closed. The switches are mounted so that both lever arms are contacted by the door limiter arm at the same time.

(2) Interlock adjustments:

(a) Cabinet interlock: None

(b) Door interlocks: Switch lever arms may be bent and the switch mounting bracket may be positioned by the use of mounting screws in oblong holes.

(3) Door movement for interlock operation:

(a) Door interlock A: When oven arrived, the latch would operate the microswitch after moving it about half of the required unlatching movement.

(b) Door interlocks B and C: 7 mm

(4) Worst-case interlock adjustment:

(a) Door interlock A: The microswitch arm and location can be adjusted so that releasing the latch will not turn off the oven.

(b) Door interlocks B and C: With the mounting bracket adjusted to the lower end of its mounting slots, the door may be opened 20 mm before the microswitches shut the oven off.

(5) Other door or hinge adjustments: None

(6) Interlock defeating technique: The interlocks could not be easily defeated from the front of the oven.

(7) Door latch description: A mechanical latch provides positive door closure.

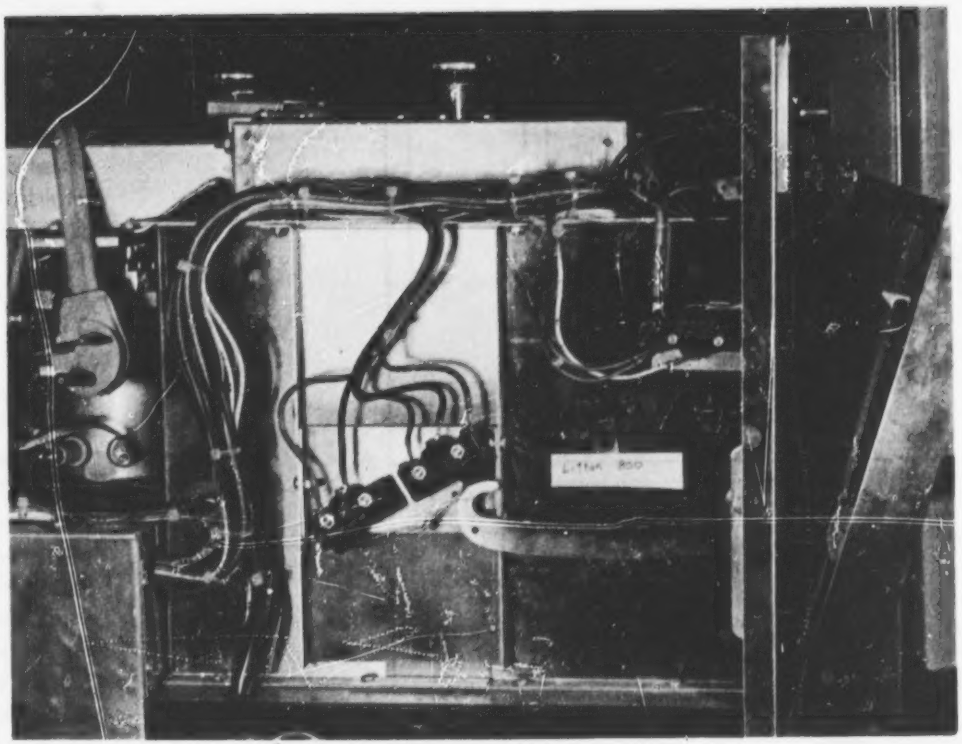
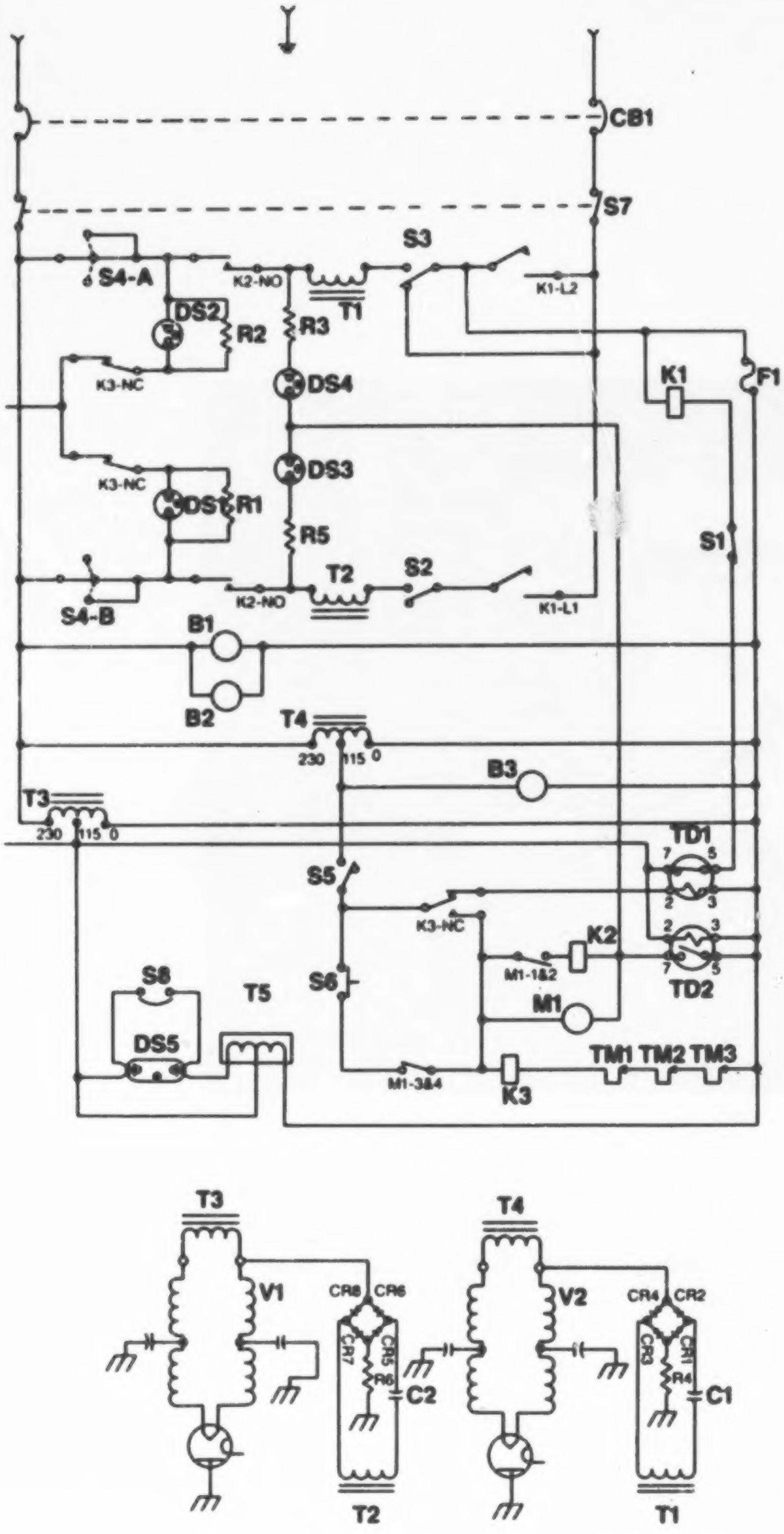


Figure 13. Litton Model 800 door interlock A mounted on door latch behind front panel, and door interlocks B and C mounted on side of oven.


CB1
S7
S3
S4-A
K2-NO
T1
K1-L2
DS2
R2
R3
K1
F1
K3-NC
DS4
DS3
K3-NC
DS1
R1
R5
S1
S2
S4-B
K2-NO
T2
K1-L1
B1
B2
T4
230
115
0
B3
T3
230
115
0
TD1
7
5
2
3
S5
K3-NC
K2
TD2
S8
T5
S6
M1-1&2
M1
DS5
M1-3&4
K3
TM1 TM2 TM3
T3
T4
V1
V2
CR8
CR6
CR7
CR5
R6
C2
CR4
CR2
CR3
CR1
R4
C1
T2
T1

LEGEND

B1-2	Blower Motors
B3	Stirrer Motor
C1-2	Capacitors
CB1-F2	Circuit Breaker or 20 AMP fuse
CR 1 thru 8	Diodes
DS1-2	Ready Lights
DS3-4	Cook Lights
DS5	Cavity Light
F1	Fuse 3 AMP
K1	Holding Relay
K2	Cook Relay
K3	Relay - Timer Circuit
L1-2	Contacts For K1
M1	Timer
M1-1 thru 4	Timer Switch Contacts
R1-2	Resistor for Ready Lights 120 K - 1W
R3-5	Resistor on K1 Terminal Board 100 K - 1W
R4-6	Resistor - Plate Current Monitoring 100 OHM 10 Watt
S1	Wrapper Interlock Switch
S2-3	Cam Arm Switches
S4A-B	Hi Lo Switch
S5	Door Latch Switch
S6	Cook Switch
S7	On Off Switch
S8	Lamp Starter
T1-2	Plate Transformer
T3-4	Filament Transformer
T5	Lamp Ballast
TD1	180 Second Automatic Shut Down Time Delay
TD-2	10 Second Automatic Start Up Relay
TM1-3	Thermal Protector
TM2	Load Sensor
V1-2	Magnetron

Figure 14. Schematic of Litton Model 800.

5.4.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Litton

Model 800

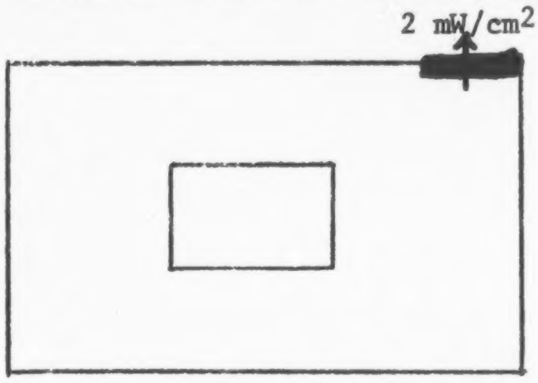
Serial Number 1319

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

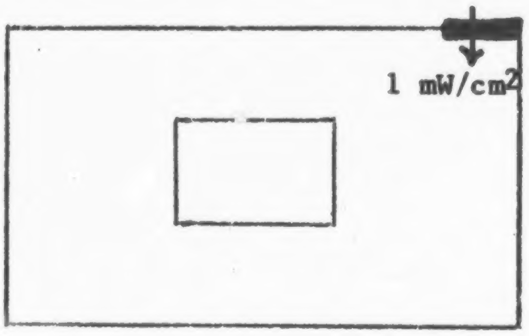
(a) Without film

Meter #1
Probes #1, #4



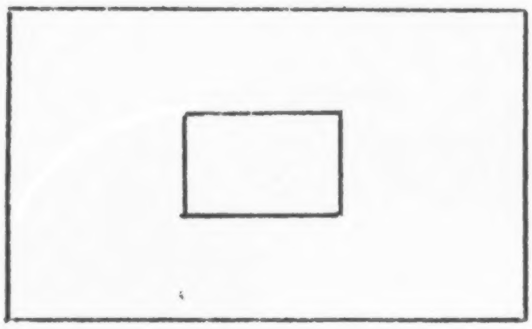
(b) With film

Meter #1
Probes #1, #4



(c) Door opening leakage

Meter #2
Probe #6



Less than 0.5 mW/cm^2

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 1,500 mW/cm^2 - 4,500 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

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5.5 GARLAND-WELBILT MODEL EM-1 OVEN

5.5.1 Summary

The Garland-Welbilt Model EM-1 microwave oven is of domestic size and power level. When the door is in the latched closed position, operation is controlled by one rocker arm on-off switch, four pushbutton timer switches, and one pushbottom start switch. A red pilot light indicates when the oven is in operation.

Two safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is a microswitch mounted on the upper front of the oven and operated by the door handle latch. This microswitch depends on latch movement rather than door movement. The second interlock is a microswitch located on the right side of the oven and operated by a six-inch shaft attached to the door. This microswitch depends on door movement for operation.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a metal-to-metal door pressure seal is used to eliminate leakage. No viewing screen is located on this oven.

Microwave power is fed into the cavity through the back wall by means of a waveguide, and a stirrer is used for proper energy distribution. This stirrer rotates at 120 revolutions per minute.

5.5.2 Technical Specifications

Manufacturer: Garland-Welbilt

Model: EM-1

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Swedish Manufacturer

Magnetron output power: 750 to 1000 W

Magnetron lifetime: 1500 to 2000 hours

Magnetron current: 680 mA

Line power requirements: 115 V, 15 A for 750 W output
115 V, 20 A for 1000 W output

Type of generator cooling: Air

Inner cavity dimensions: 16-1/2 inches by 14-1/2 inches by 11-1/4 inches

Controls: "On-Off" switch, "Cook" button, four-pushbutton timer

Viewing screen type: None

Type of door seal: Metal-to-metal pressure

Indicators of microwave generator operation: Red pilot light and depressed operating controls indicate oven is on.

5.5.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Door interlock A: Microswitch mounted on latch mechanism on front panel of oven door handle. (Latch lifts microswitch contact).

(b) Door interlock B: Simple spring-loaded two-contact switch located on right side of oven, operated by a 6-inch shaft attached to the door. The shaft depresses plunger, breaking the circuit.

(2) Interlock adjustments:

(a) Door interlock A: None

(b) Door interlock B: The entire switch can be moved to easy access without breaking electrical connections.

(3) Door movement for interlock operation:

(a) Door interlock A turns off when latch handle is raised, before door opens.

(b) Door interlock B turns off oven after door has opened 16 mm.

(4) Worst-case interlock adjustments:

(a) Interlock A cannot be adjusted.

(b) Interlock B can be moved so that door can open fully while oven is still operating.

(5) Other door and hinge adjustments: None

(6) Intentional interlock defeating technique:

(a) Interlock A can be defeated by taping switch lever closed.

(b) Interlock B can be defeated by removing two screws holding switch mechanism and moving switch away from the triggering shaft.

(7) Door latch description: The door latch consists of a loaded rocker arm mounted on the door with a handle. This arm springs up to grab a catch on the front panel.

(8) Suggested interlock improvements: Interlock B should be incorporated into the oven in such a way that it cannot be easily moved away from the triggering rod.

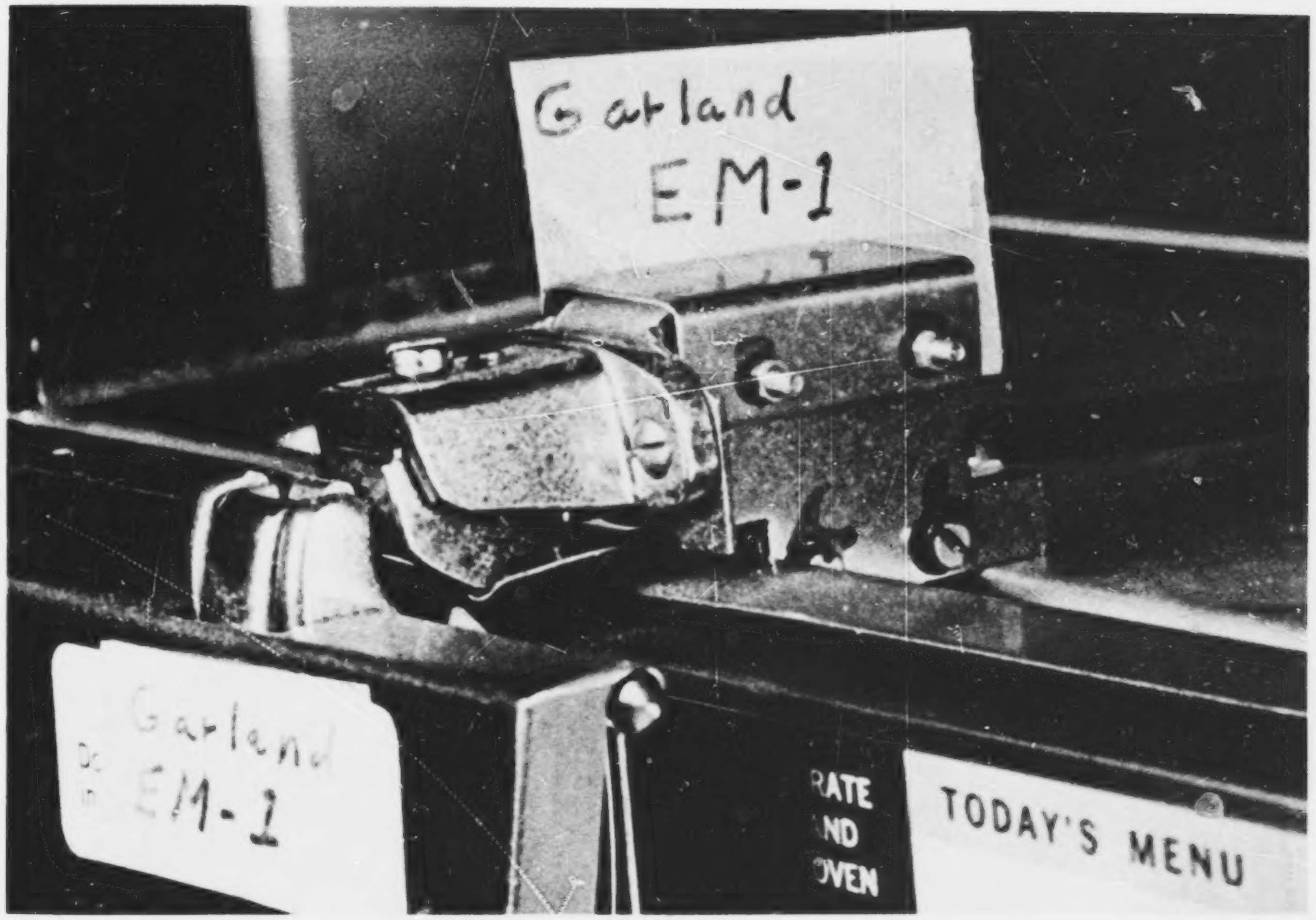

Garland
EM-1
Garland
EM-1
RATE
ND
OVEN
TODAY'S MENU

Figure 15. Garland Model EM-1 interlock A mounted on door latch mechanism.

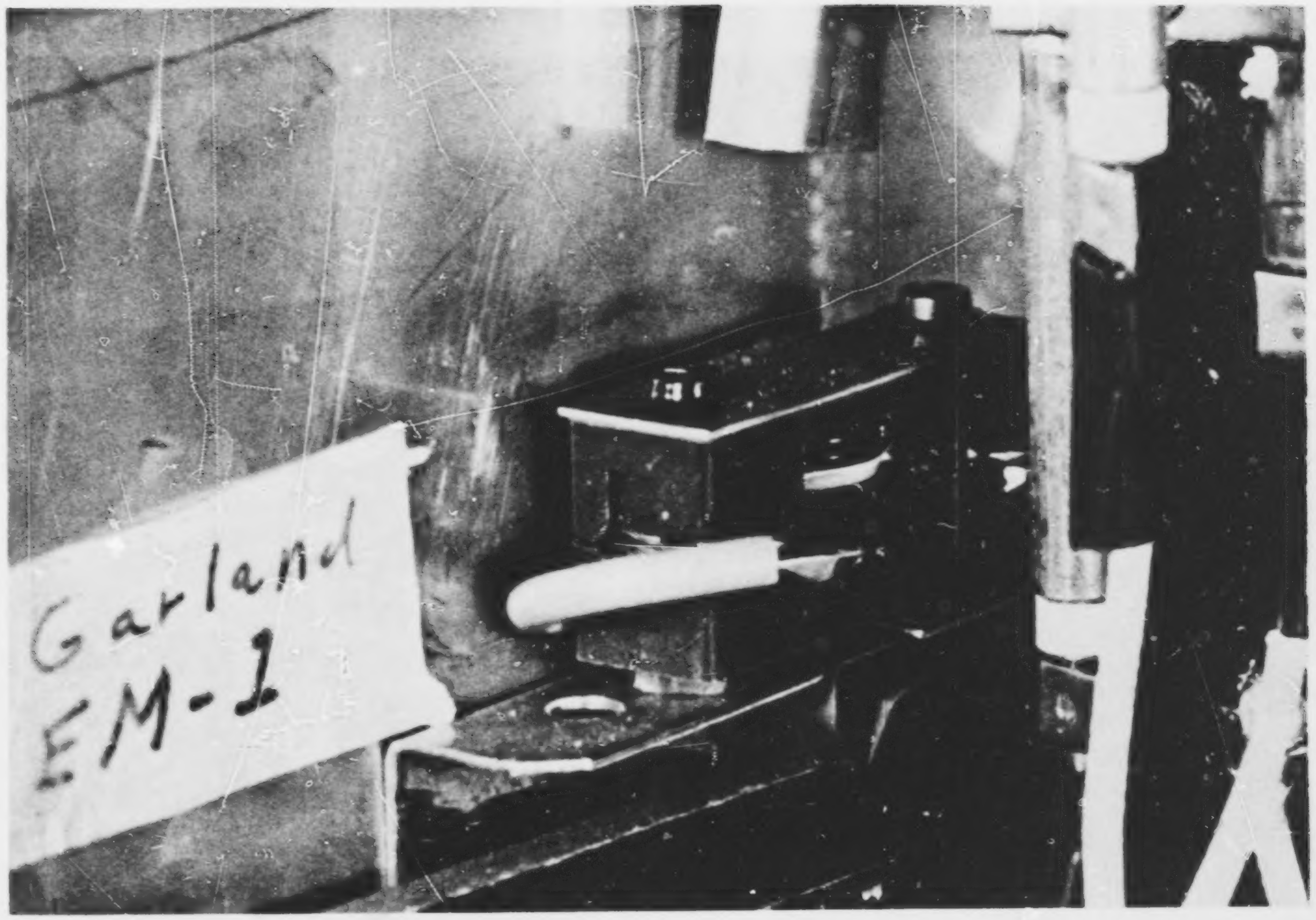

Garland
EM-1

Figure 16. Garland Model EM-1 interlock B mounted on right side of oven.

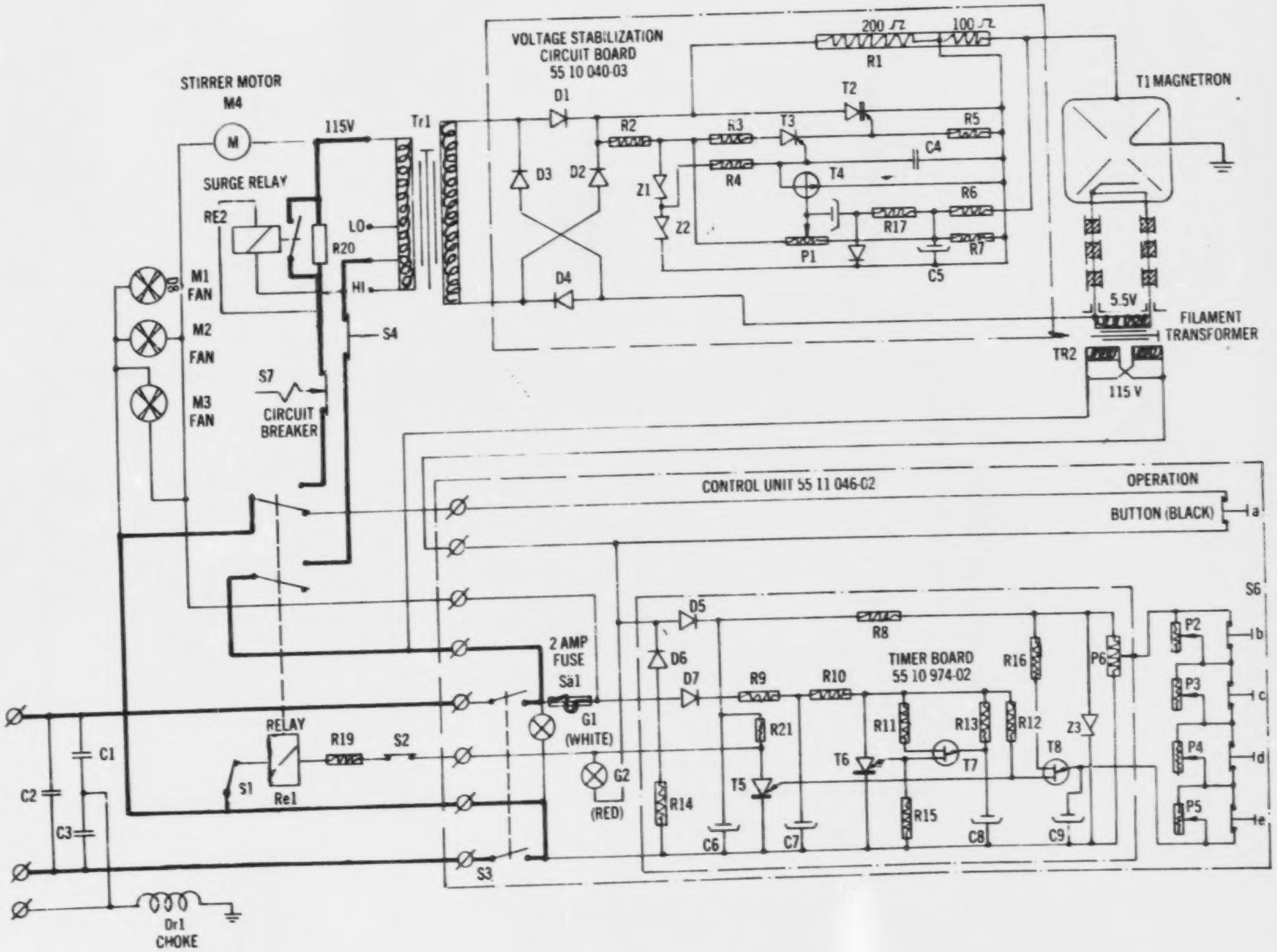

VOLTAGE STABILIZATION
CIRCUIT BOARD
55 10 040-03
200 Ω
100 Ω
R1
T1 MAGNETRON
STIRRER MOTOR
M4
M
115V
Tr1
D1
D2
D3
D4
R2
R3
R4
R5
R6
R7
R17
T2
T3
T4
C4
C5
P1
Z1
Z2
SURGE RELAY
RE2
R20
LO
HI
S4
M1
FAN
M2
FAN
M3
FAN
S7
CIRCUIT
BREAKER
5.5V
FILAMENT
TRANSFORMER
TR2
115 V
CONTROL UNIT 55 11 046-02
OPERATION
BUTTON (BLACK)
a
S6
b
c
d
e
P2
P3
P4
P5
P6
2 AMP
FUSE
Sa1
G1
(WHITE)
G2
(RED)
RELAY
Re1
R19
S2
S1
S3
C1
C2
C3
Dr1
CHOKE
D5
D6
D7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R21
TIMER BOARD
55 10 974-02
T5
T6
T7
T8
Z3
C6
C7
C8
C9

Figure 17. Schematic of Garland Model EM-1

5.5.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Welbilt-Garland

Model EM-1

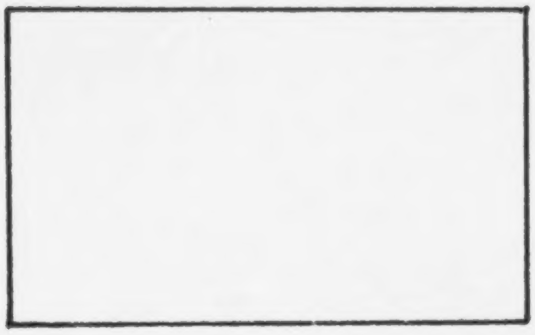
Serial Number 133308

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR

(a) Without film

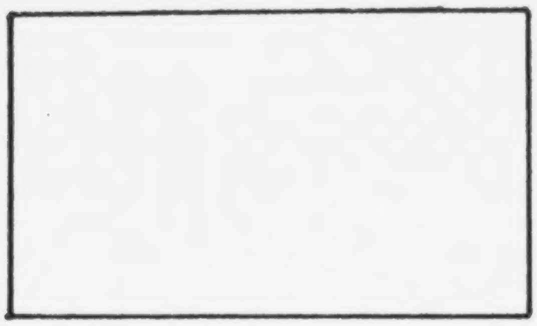
Meter #1
Probes #1, #4



All readings below 0.5 mW/cm^2

(b) With film

Meter #1
Probes #1, #4



All readings below 0.5 mW/cm^2

(c) Door opening leakage

Meter #1
Probe #6

All readings below 0.5 mW/cm^2

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 435 mW/cm^2 - 1,300 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.6 MAGIC CHEF MODEL MC-75.01 OVEN

5.6.1 Summary

The Magic Chef Model MC-75.01 microwave oven is designed for either domestic or commercial use. When the door is in the closed position, operation is controlled by one on-off switch and six pushbutton timer switches. A ready and a cooking light are provided to indicate the oven status.

Two safety interlocks are employed to disrupt microwave power when the door is opened. Both interlocks are microswitches mounted behind the front panel of the oven and operated by two posts fastened to the oven door which go through small holes in the panel when the door is closed. Both of these interlocks are considered accessible interlocks. The operation of these two interlocks depends on door motion. The door has a latch handle to hold it in the closed position.

The door is left hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a capacitive pressure seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity by a waveguide through the bottom of the cavity floor. A microwave-transparent material is used to support the oven load in the cavity. No stirrer is located in this oven.

5.6.2 Technical Specifications

Manufacturer: Magic Chef

Model: MC-75.01

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L5001

Magnetron output power: 1000 W

Magnetron lifetime: 3 to 5 years

Magnetron current: 550 mA

Line power requirements: 120V, 60 Hz

Type of generator cooling: Air

Inner cavity dimensions: 12 inches by 12-1/2 inches by 6-1/2 inches

Controls: "On-off" switch, six-pushbutton timer, "Ready" light, "Cooking" light.

Viewing screen type: Metal screen

Type of door seal: Capacitive pressure seal

Indicators of microwave generator operation: Two pilot lamps on the front panel, a red one indicating "heating" and an orange one indicating "ready to heat," notify the oven user of voltages being applied to the magnetron. For the cooking operation, the "heating" indicator is lighted and the "ready to heat" is dark.

5.6.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Cabinet interlock: One microswitch mounted at back of oven chassis; microswitch lever arm directly operated by cabinet wall. Removal of cabinet cover (2 screws) turns off the oven.

(b) Door interlock A: Microswitch mounted behind front panel of oven; operated by a post fastened to the oven door which goes through a small hole in the panel when the door is closed. The post pushes against the microswitch lever.

(c) Door interlock B: Same as A but mounted 8 inches below A on the front panel.

(2) Interlock adjustments:

(a) Cabinet interlock: Elongated mounting holes for microswitch allow movement of the switch position. In addition, switch lever arm may be bent.

(b) Door interlock A: Elongated microswitch mounting holes allow setting the location of the switch. In addition, switch lever arm may be bent.

(c) Door interlock B: Same as A.

(3) Door movement for interlock operation:

(a) Door interlocks A and B: When the oven arrived from supplier, door could open 2.5 mm from completely closed position before oven ceased operation.

(4) Worst-case interlock adjustments: By adjusting microswitch to worst-case position (via mounting holes), the oven will not shut off when the door is completely open.

(5) Other door or hinge adjustments: Hinges may be shimmed (would not greatly affect interlock operation).

(6) Intentional interlock defeating technique: Two objects less than 5 mm in diameter, when inserted into the two holes on the oven front panel to operate door interlocks A and B, will allow oven to operate with the door completely open.

(7) Door latch description: A mechanical latch provides positive closure.

(8) Suggested interlock improvements: A more tamper-proof interlock system could be built if one of the interlocks were operated by an arm on the door, near the hinge, and inside the oven where it could not be reached by the user.

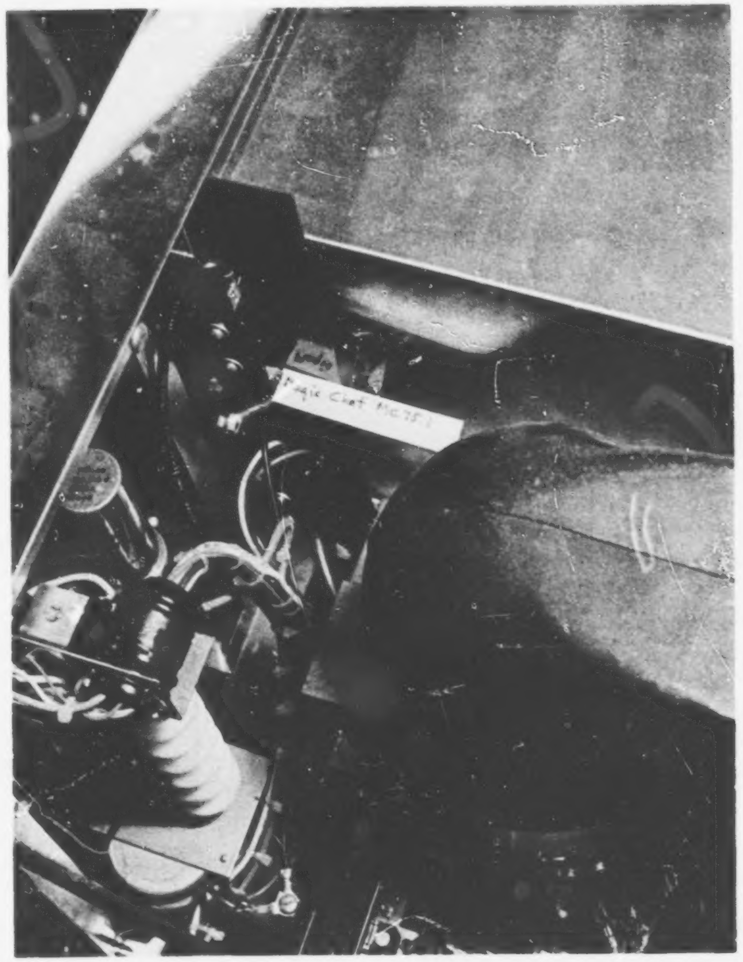

Magic Chef MC75.1

Figure 18. Magic Chef Model MC 75.01 door interlocks A and B (rear view).

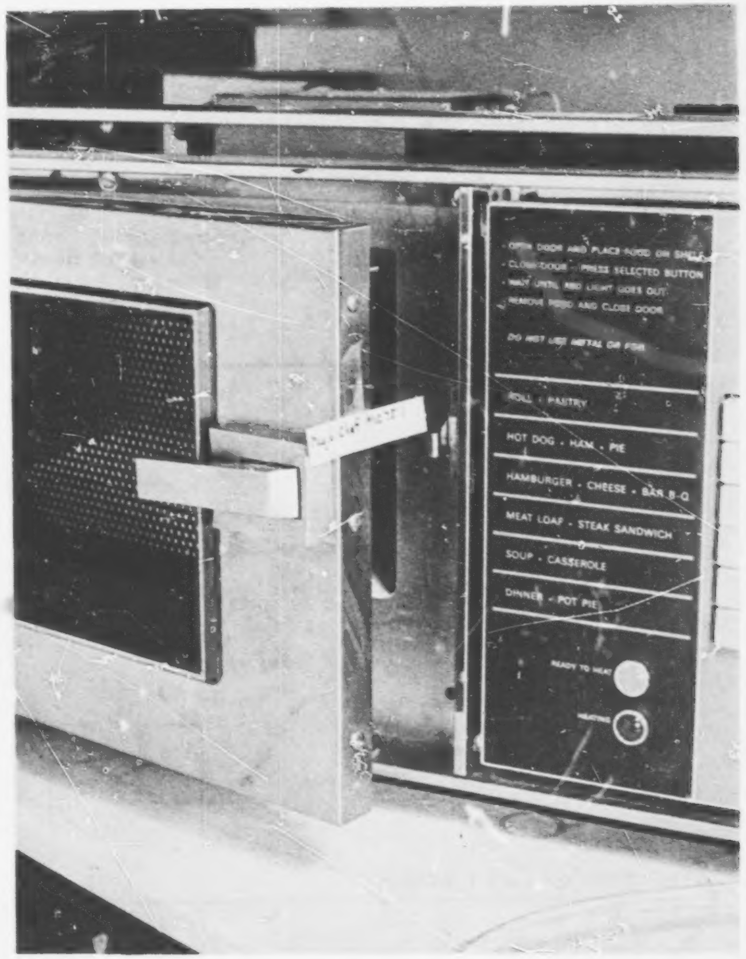

OPEN DOOR AND PLACE FOOD ON SHELF
CLOSE DOOR - PRESS SELECTED BUTTON
WAIT UNTIL RED LIGHT GOES OUT
REMOVE FOOD AND CLOSE DOOR
DO NOT USE METAL OR FOIL
ROLL - PASTRY
HOT DOG - HAM - PIE
HAMBURGER - CHEESE - BAR B-Q
MEAT LOAF - STEAK SANDWICH
SOUP - CASSEROLE
DINNER - POT PIE
READY TO HEAT
HEATING

Figure 19. Magic Chef Model MC 75.01 door interlocks A and B mounted behind front panel of oven.

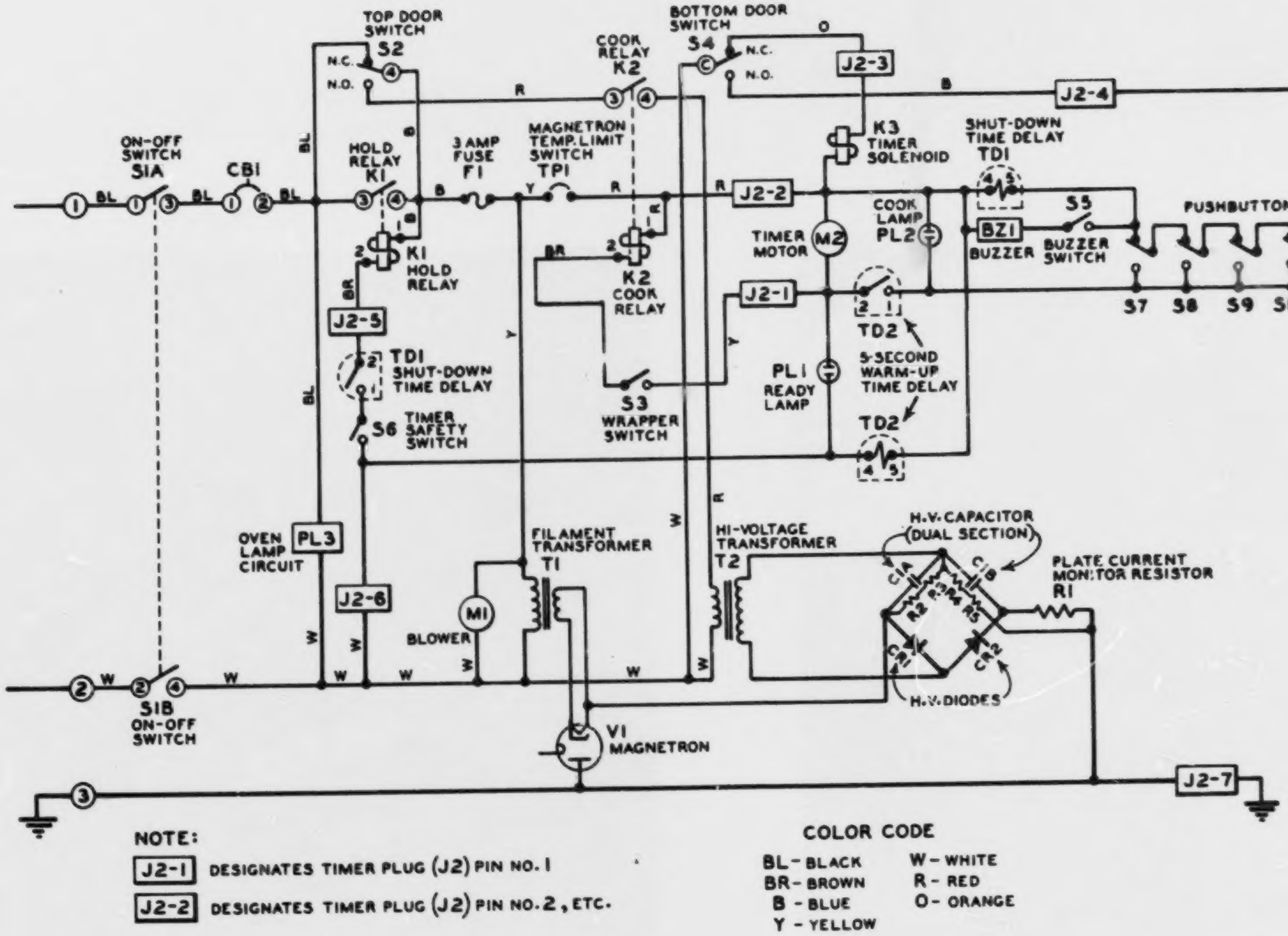

TOP DOOR SWITCH S2
N.C.
N.O.
COOK RELAY K2
BOTTOM DOOR SWITCH S4
N.C.
N.O.
J2-3
J2-4
ON-OFF SWITCH S1A
CB1
HOLD RELAY K1
3 AMP FUSE F1
MAGNETRON TEMP. LIMIT SWITCH TP1
J2-2
K3 TIMER SOLENOID
SHUT-DOWN TIME DELAY TD1
PUSHBUTTON SWITCHES
COOK LAMP PL2
TIMER MOTOR M2
BZ1 BUZZER
S5 BUZZER SWITCH
K1 HOLD RELAY
K2 COOK RELAY
J2-1
J2-5
TD2
S7 S8 S9 S10 S11 S12
TD1 SHUT-DOWN TIME DELAY
S6 TIMER SAFETY SWITCH
S3 WRAPPER SWITCH
PL1 READY LAMP
5-SECOND WARM-UP TIME DELAY
TD2
OVEN LAMP CIRCUIT
PL3
J2-6
FILAMENT TRANSFORMER T1
HI-VOLTAGE TRANSFORMER T2
H.V. CAPACITOR (DUAL SECTION)
C1A
C1B
R2 R3 R4 R5
PLATE CURRENT MONITOR RESISTOR R1
CR1
CR2
H.V. DIODES
M1
BLOWER
S1B ON-OFF SWITCH
V1 MAGNETRON
J2-7
BL
B
BR
Y
R
W
O
NOTE:
J2-1 DESIGNATES TIMER PLUG (J2) PIN NO. 1
J2-2 DESIGNATES TIMER PLUG (J2) PIN NO. 2, ETC.
COLOR CODE
BL - BLACK
BR - BROWN
B - BLUE
Y - YELLOW
W - WHITE
R - RED
O - ORANGE

Figure 20. Schematic of Magic Chef Model MC 75.01

5.6.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Magic Chef

Model MC 75.01

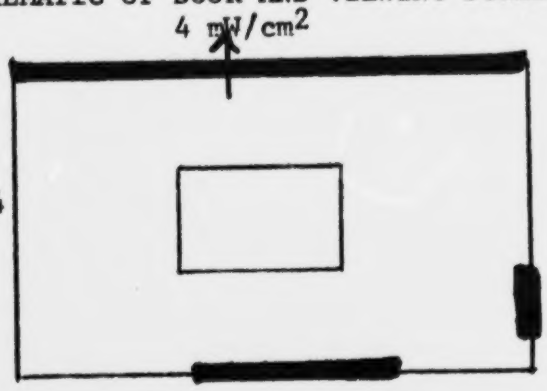
Serial Number 1674

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

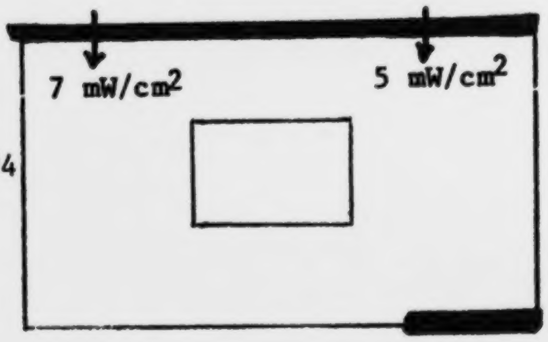
(a) Without film

Meter #1
Probes #1, #4



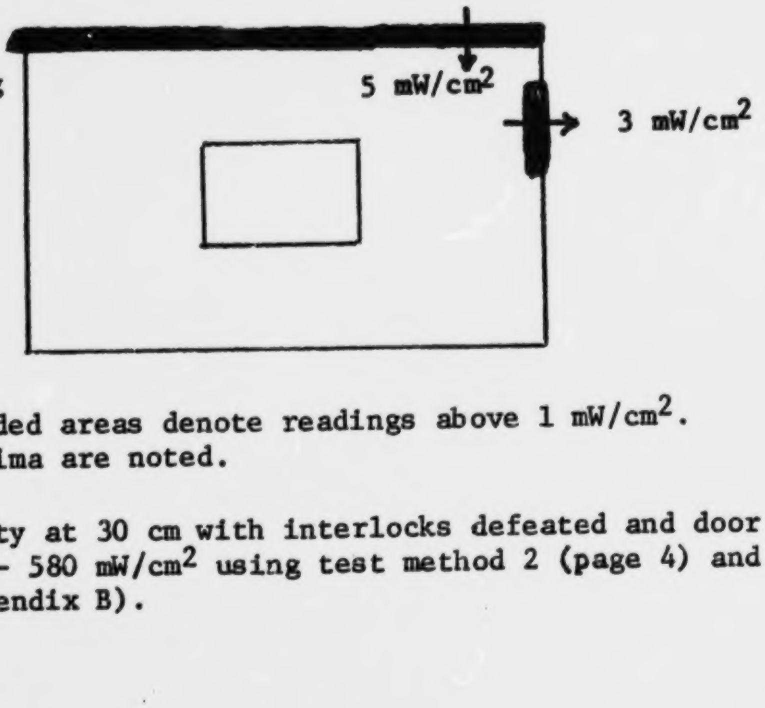
(b) With film

Meter #1
Probes #1, #4



(c) Door opening leakage

Meter #2
Probe #6



Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 190 mW/cm^2 - 580 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

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5.7 AMANA MODELS RR-1 AND RR-2 OVENS

5.7.1 Summary

The Amana Models RR-1 and RR-2 ovens are designed for domestic use. They are identical from outside appearances except that the RR-2 has a stop switch next to the start and light switches. When the door is in the latched closed position, operation is controlled by two rotary timers and the start and stop pushbutton switches.

Three safety interlocks are employed to disrupt power when the door is opened. Two of the interlocks are microswitches mounted on either side of the oven about eight inches behind the front panel. Separate arms fastened to the oven door contact lever arms on the microswitches, which in turn operate the switches. The third interlock is located directly behind the front panel along the right side of the door and is operated by the door contacting a plunger which protrudes through the front oven panel. All three interlocks depend on the door motion for operation.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a choke seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the top of the cavity by means of a waveguide, and a stirrer is located in the oven to distribute the energy. This stirrer rotates at 90 revolutions per minute.

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5.7.2 Technical Specifications

Manufacturer: Amana

Model: RR-1 and RR-2

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Raytheon QKH-1381 B

Magnetron output power: 750 W

Magnetron lifetime: 5 years, 1500 to 2000 operating hours

Magnetron current: 300 mA

Line power requirements: 115V

Type of generator cooling: Air

Inner cavity dimensions: 9-1/8 inches by 14-5/8 inches by 13-3/8 inches

Controls: RR-1: "Start" button, "Light" button, 2 timer dials; RR-2: "Start" button, "Stop" button, "Light" button, 2 timer dials

Viewing screen type: Metal mesh

Type of door seal: Choke door seal

Indicators of microwave generator operation: A light on the timer dials indicates that power is being applied to the magnetron. Front panel dark condition indicates the magnetron is off.

5.7.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Door interlock A: One microswitch mounted on the side of the oven about eight inches behind the front panel. An arm fastened to the oven door contacts a lever arm on the microswitch which operates the switch plunger.

(b) Door interlock B: Same as interlock A except located on the other side of the oven.

(c) Door interlock C: One microswitch mounted behind oven door frame triggered by a plunger which protrudes through the frame. The plunger is activated by the oven door.

(2) Interlock adjustments:

(a) Adjustment to A: No mounting hole adjustments. The switch lever arm, however, may be bent.

(b) Adjustments to B: Same as A.

(c) Adjustments to C: None

(3) Door movement for interlock operation:

(a) Interlock A: 4 mm

(b) Interlock B: 3 mm

(c) Interlock C: 5 mm

(4) Worst-case interlock adjustment: 10 mm

(5) Other door or hinge adjustments: None

(6) Intentional interlock defeating technique: Interlocks A and B could not be easily defeated from the front of the oven. Interlock C could be held or taped in a closed position.

(7) Door latch description: Spring pressure keeps the door closed.

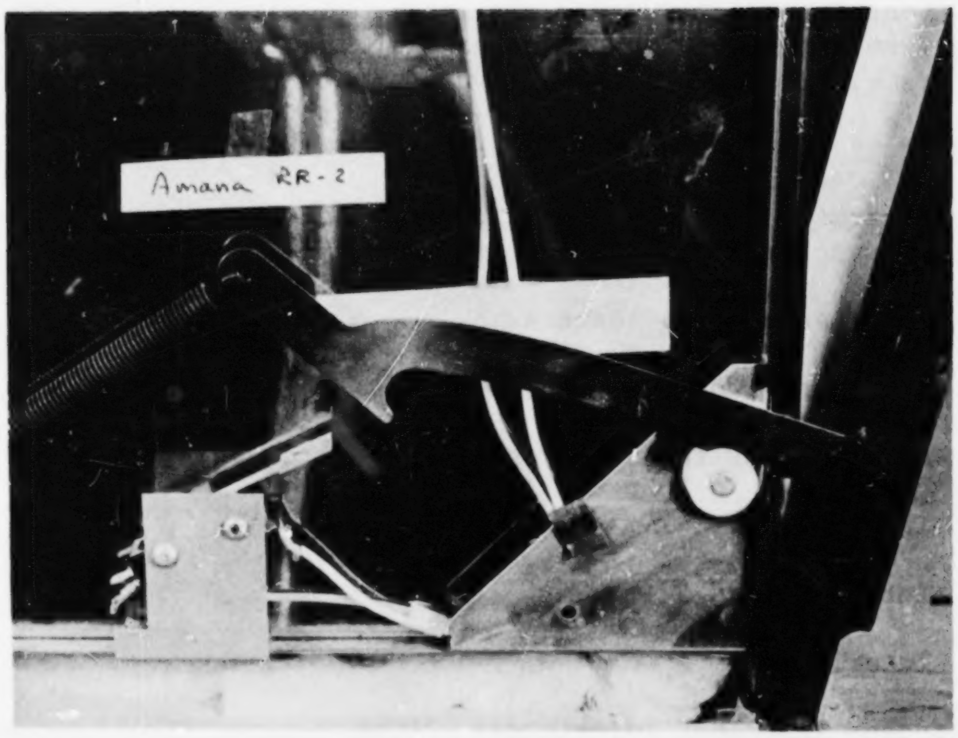
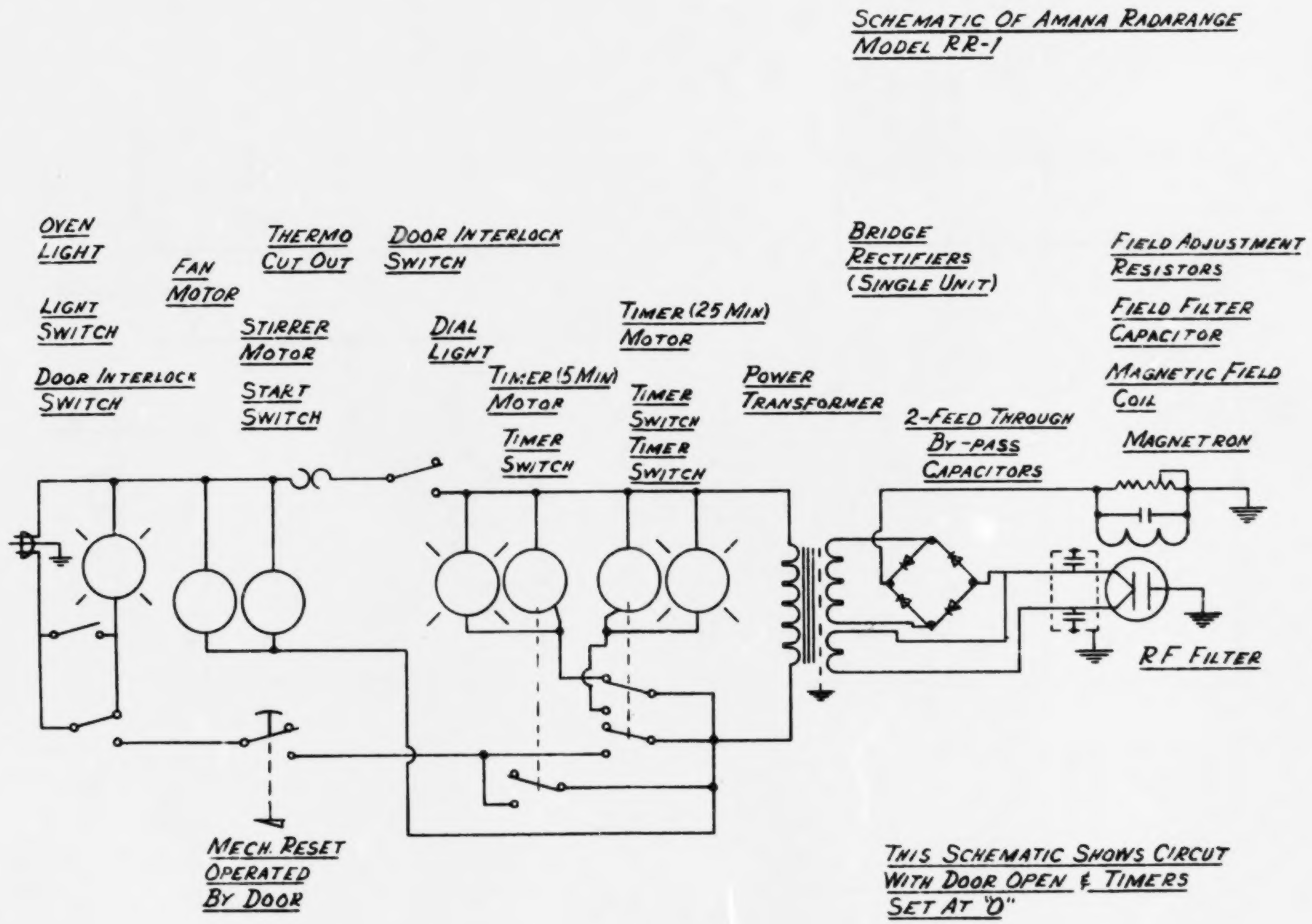
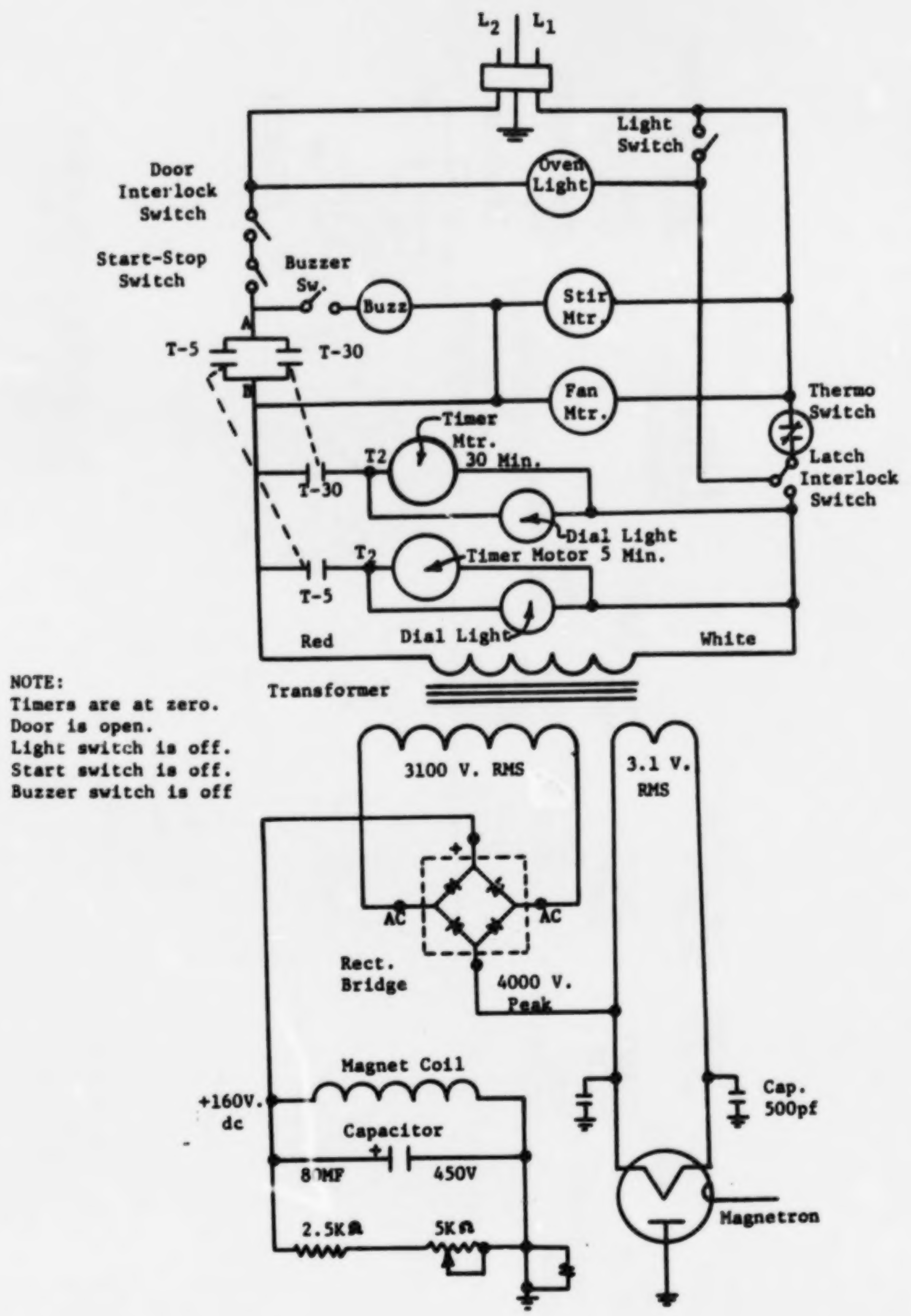


Figure 21. Amana Model RR-2 interlocks mounted on each side panel.


SCHEMATIC OF AMANA RADARANGE
MODEL RR-1
OVEN LIGHT
LIGHT SWITCH
DOOR INTERLOCK SWITCH
FAN MOTOR
THERMO CUT OUT
STIRRER MOTOR
START SWITCH
DOOR INTERLOCK SWITCH
DIAL LIGHT
TIMER (5 MIN) MOTOR
TIMER SWITCH
TIMER (25 MIN) MOTOR
TIMER SWITCH
TIMER SWITCH
POWER TRANSFORMER
BRIDGE RECTIFIERS (SINGLE UNIT)
2-FEED THROUGH BY-PASS CAPACITORS
FIELD ADJUSTMENT RESISTORS
FIELD FILTER CAPACITOR
MAGNETIC FIELD COIL
MAGNETRON
RF FILTER
MECH. RESET OPERATED BY DOOR

THIS SCHEMATIC SHOWS CIRCUT WITH DOOR OPEN & TIMERS SET AT "0"

Figure 22. Schematic of Amana Radarange Model RR-1.


L2
L1
Light Switch
Oven Light
Door Interlock Switch
Start-Stop Switch
Buzzer Sw.
Buzz
Stir Mtr.
A
T-5
T-30
B
Fan Mtr.
Thermo Switch
Timer Mtr. 30 Min.
T2
T-30
Dial Light
Latch Interlock Switch
T2
Timer Motor 5 Min.
T-5
Red
Dial Light
White
Transformer
3100 V. RMS
3.1 V. RMS
AC
AC
Rect. Bridge
4000 V. Peak
Magnet Coil
+160V. dc
Capacitor
80MF
450V
2.5KΩ
5KΩ
Cap. 500pf
Magnetron

NOTE:
Timers are at zero.
Door is open.
Light switch is off.
Start switch is off.
Buzzer switch is off

Figure 23. Schematic of Amana Radarange Model RR-2

5.7.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Amana

Model RR-2 (applicable to RR-1)

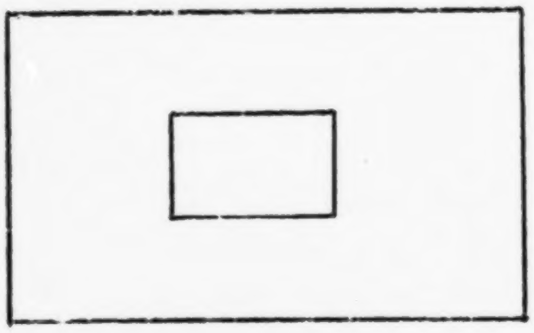
Serial Number S18357883

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

(a) Without film

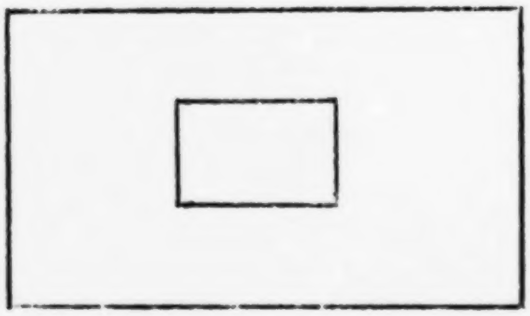
Meter #2
Probe #6



All leakage less than $0.5\ mW/cm^2$

(b) With film

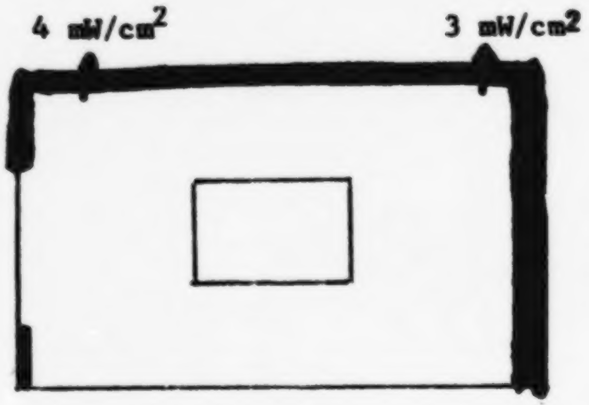
Meter #2
Probe #6



All leakage less than $0.5\ mW/cm^2$

(c) Door opening leakage

Meter #2
Probe #6



Shaded areas denote readings above $1\ mW/cm^2$.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: $785\ mW/cm^2$ using test method 1 (page 4) and instrument set #2 (appendix B.)

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5.8 SEARS-KENMORE MODEL 103.9946700 OVEN

5.8.1 Summary

The Sears-Kenmore Model 103.9946700 is designed for domestic use. This unit is a double oven with the upper cavity being the microwave portion. When the door is in the closed position, operation is controlled by a high-low switch and a microwave rotary timer.

Two safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is a microswitch mounted behind the front panel with a plunger protruding through the front panel that is operated by the oven door. The second interlock is a reed relay located near the edge of the oven door inside a hinged control panel. A fixed permanent magnet located inside the door controls this relay operation. Both interlocks depend on door motion for operation. A door handle latch is employed to hold the door in the closed position.

The door is left hinged and opens greater than 90 degrees. When the door is closed and the oven is operating normally, a metal-to-metal mesh seal is used to eliminate leakage. A viewing screen is located on the door with protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed by waveguide through the top of the cavity, and a stirrer is used to distribute the energy.

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5.8.2 Technical Specifications

Manufacturer: Sears-Kenmore

Model: 103.9946700

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L 5001

Magnetron output power: 900 W

Magnetron current: 720 mA

Line power requirements: 220 to 240 V a.c.

Type of generator cooling: Air

Inner cavity dimensions: 15-1/2 inches by 14-1/2 inches by 11-1/2 inches

Controls: "Hi-Lo" switch, microwave timer, browning timer

Viewing screen type: Metal mesh and plastic window

Type of door seal: Metal-mesh pressure seal - silicone rubber tubing covered by double layer of woven monel mesh

Indicators of microwave generator operation: Ready light and cooking light

5.8.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Door interlock A: Microswitch mounted on front panel of oven operated by the oven door directly (plunger contacts oven door).

(b) Door interlock B: Reed relay located near edge of oven door inside a hinged control panel. A fixed permanent magnet located inside the door opens and closes relay contacts when the door is nearing the fully closed position.

(2) Interlock adjustments:

(a) Interlock A: Plunger of microswitch should be centered in hole on front panel; otherwise it could stick in a closed position if initially closed (plunger pushed in) by means other than the closing of the door.

(b) Interlock B: The reed relay may be adjusted vertically or longitudinally rotated.

(3) Door movement for interlock operation:

(a) Interlock A: 1 mm. When door is completely closed, it pushes the plunger 0.5 mm beyond "on" position.

(b) Interlock B: 11 mm

(4) Worst-case interlock adjustments:

(a) Interlock A: 5 mm

(b) Interlock B: 15 mm

(5) Other door or hinge adjustments: Hinges may be shimmed (would not greatly affect door interlocks.)

(6) Intentional interlock defeating technique:

(a) Interlock A must be defeated by jamming or taping the plunger in the "on" position.

(b) Interlock B must be actuated by placing a small magnet near the left edge of the control panel until a soft click is heard, indicating closure of the reed relay.

(7) Door latch description: Spring loaded rocker arm, tripped by protrusion from front panel.

(8) Suggested interlock improvements: Reed relay should be set so that a stronger magnet, as specified by the proposed standard for microwave ovens, is needed to close the switch.

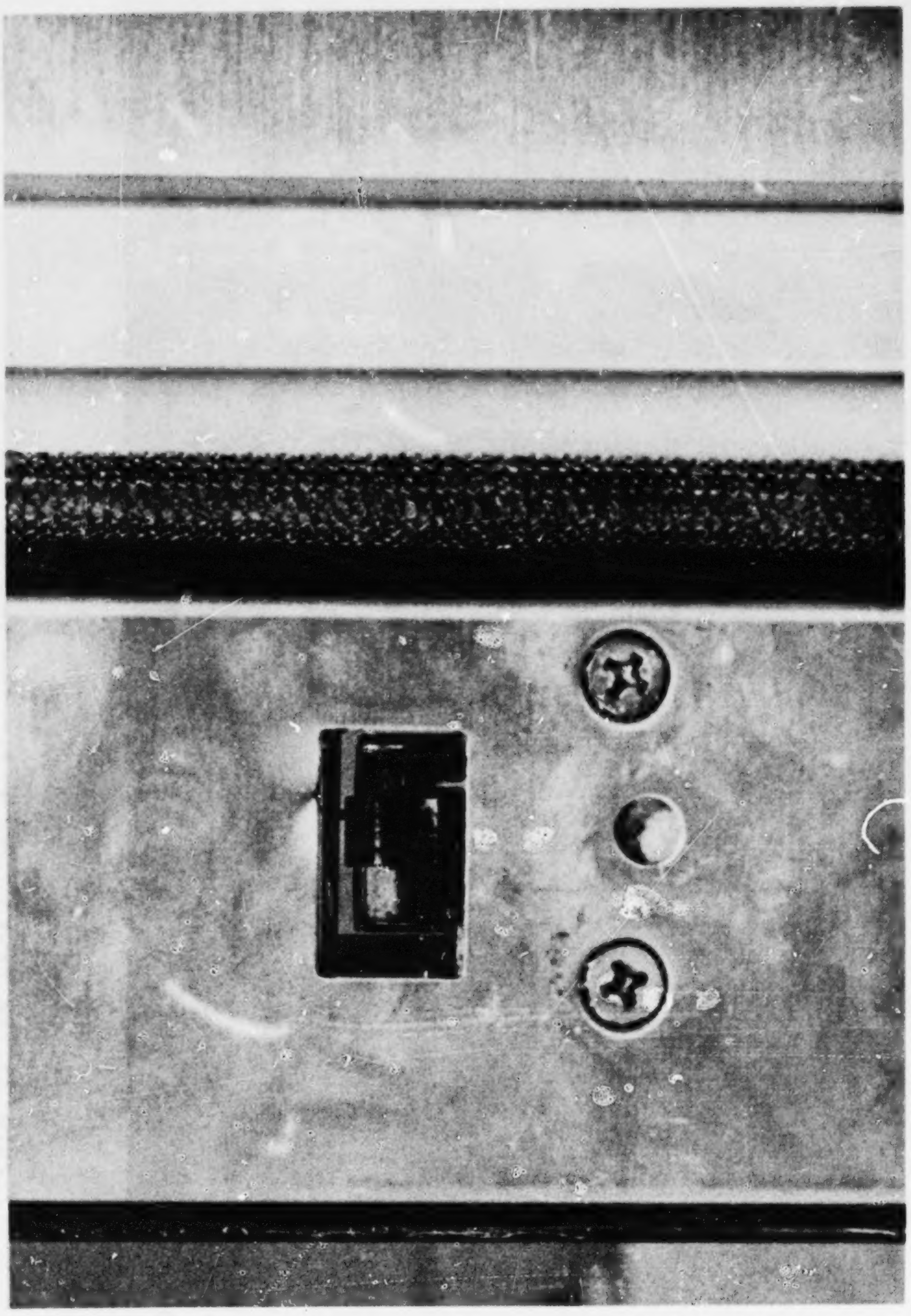


Figure 24. Sears-Kenmore Model 103.9946700 door interlock A mounted on front panel of oven.

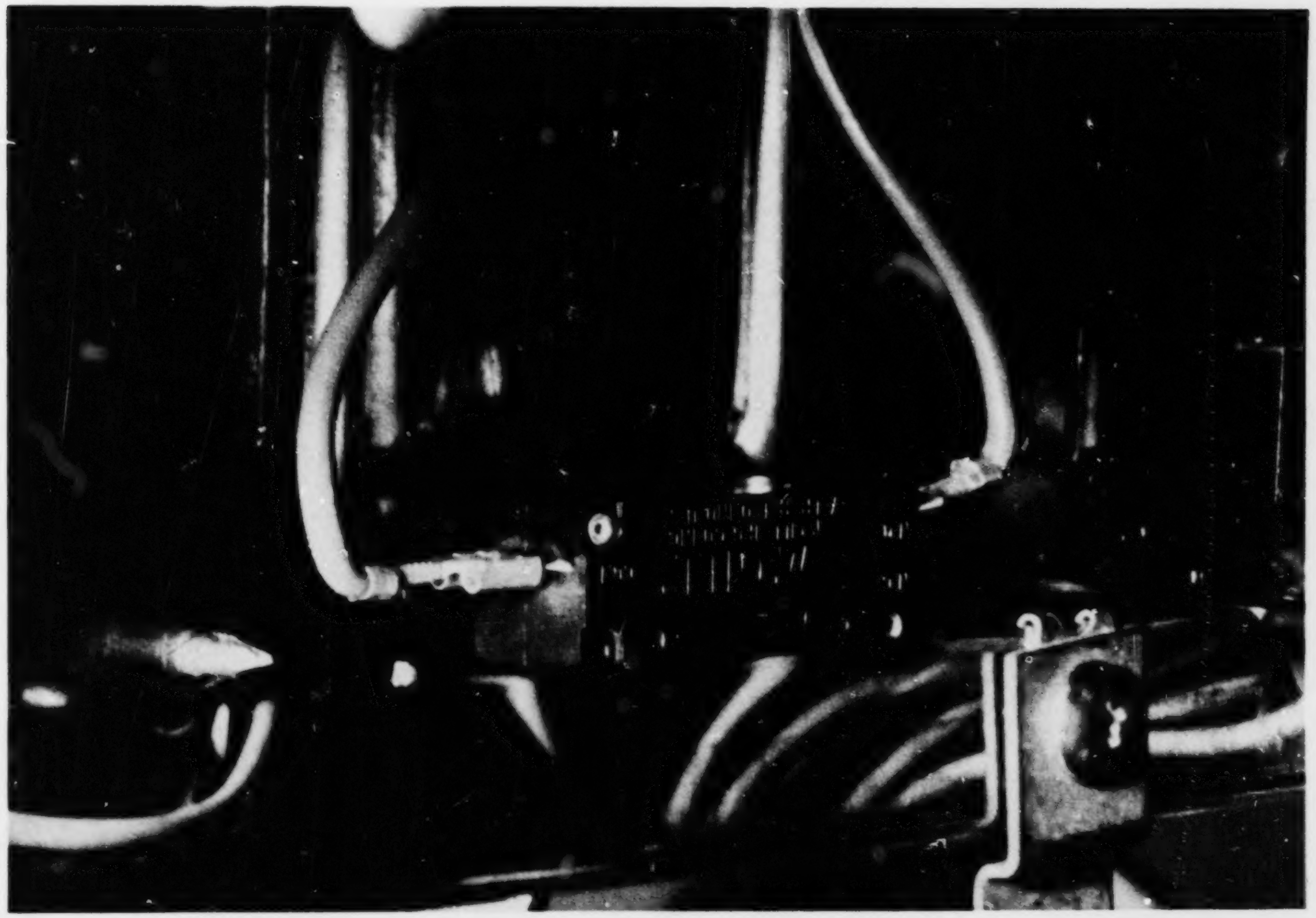


Figure 25. Sears-Kenmore Model 103.9946700 door interlock A (side view).

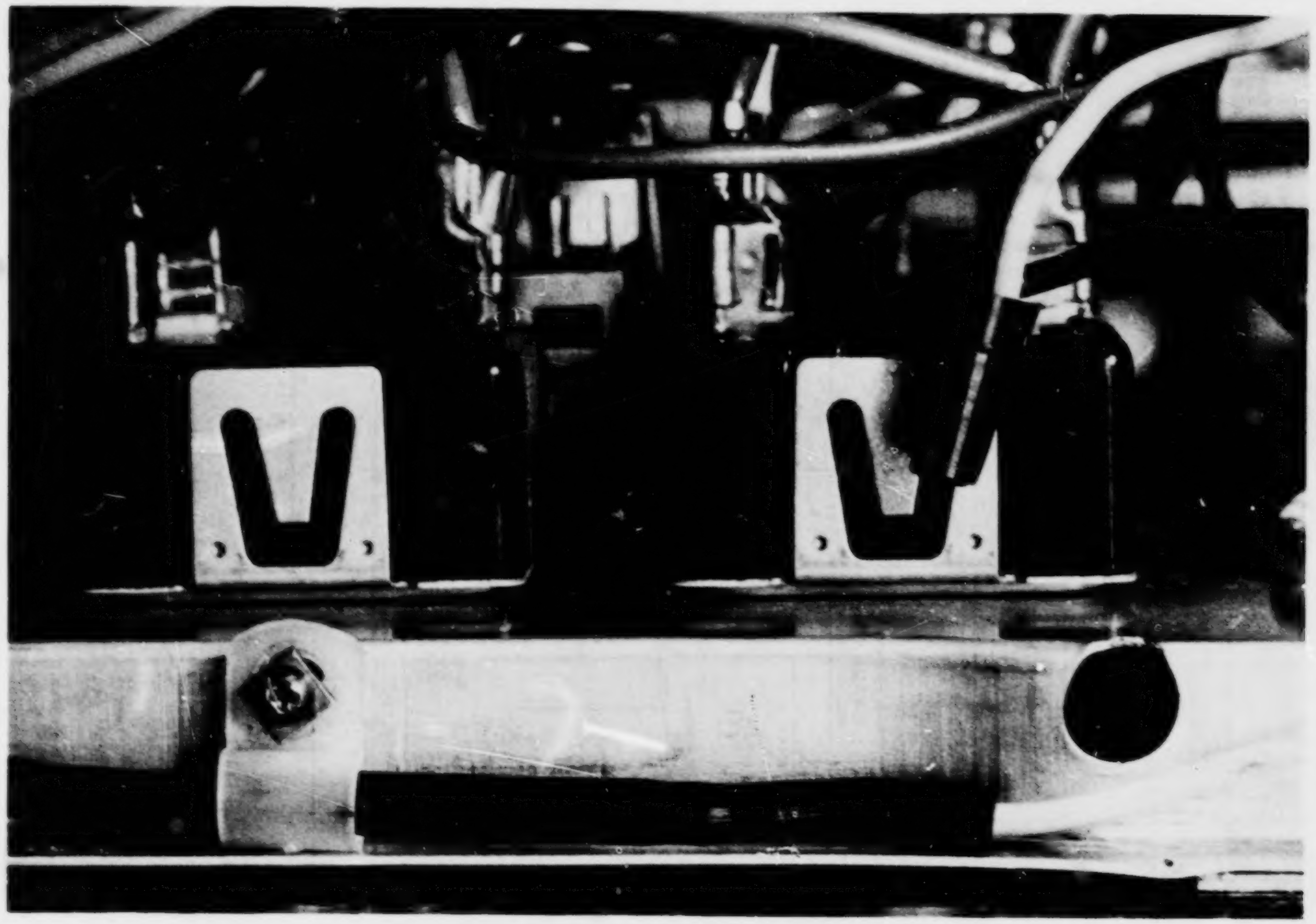


Figure 26. Sears-Kenmore Model 103.9946700 door interlock B mounted on hinged control panel.

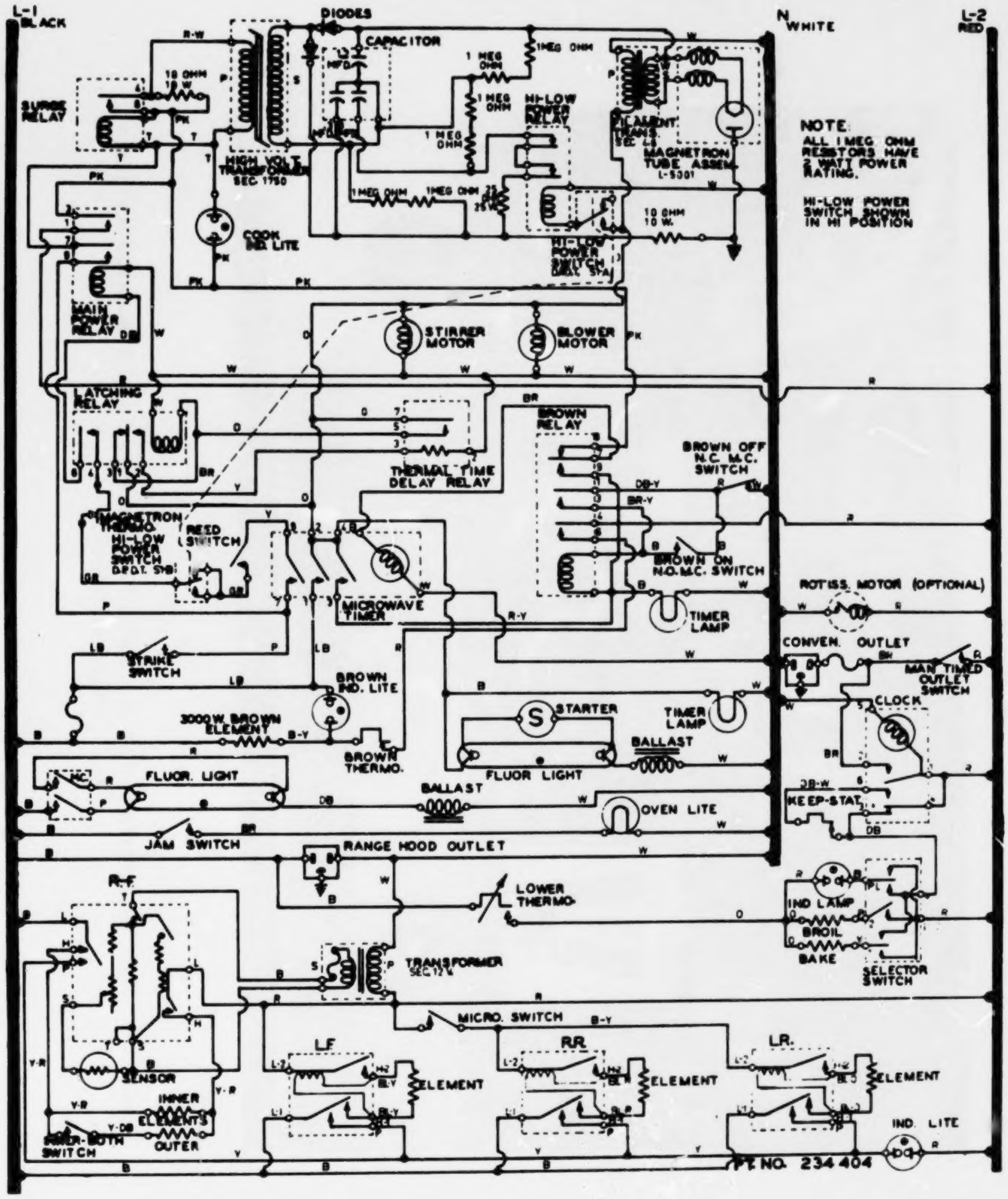

L-1 BLACK
N WHITE
L-2 RED
DIODES
CAPACITOR
SURGE RELAY
10 OHM 10 W
HIGH VOLT. TRANSFORMER SEC. 1750
COOK IND. LITE
1 MEG OHM
HI-LOW POWER RELAY
FILAMENT TRANS. SEC. 4.6
MAGNETRON TUBE ASSEM. L-5301
HI-LOW POWER SWITCH DPDT. STA.
10 OHM 10 W.
NOTE: ALL 1 MEG OHM RESISTORS HAVE 2 WATT POWER RATING.
HI-LOW POWER SWITCH SHOWN IN HI POSITION
MAIN POWER RELAY
STIRRER MOTOR
BLOWER MOTOR
LATCHING RELAY
THERMAL TIME DELAY RELAY
BROWN RELAY
BROWN OFF N.C. M.C. SWITCH
BROWN ON N.O. M.C. SWITCH
MAGNETRON THERMO.
HI-LOW POWER SWITCH DPDT. STB.
REED SWITCH
MICROWAVE TIMER
TIMER LAMP
ROTISS. MOTOR (OPTIONAL)
CONVEN. OUTLET
MAN. TIMED OUTLET SWITCH
STRIKE SWITCH
BROWN IND. LITE
3000W. BROWN ELEMENT
BROWN THERMO.
STARTER
TIMER LAMP
BALLAST
FLUOR LIGHT
CLOCK
FLUOR. LIGHT
BALLAST
OVEN LITE
KEEP-STAT
JAM SWITCH
RANGE HOOD OUTLET
R-F
LOWER THERMO.
IND LAMP
BROIL
BAKE
SELECTOR SWITCH
TRANSFORMER SEC. 12 V.
SENSOR
INNER ELEMENTS OUTER
INNER-BOTH SWITCH
MICRO. SWITCH
LF
ELEMENT
RR
ELEMENT
LR.
ELEMENT
IND. LITE
PT. NO. 234 404

Figure 27. Schematic of Sears-Kenmore Model 103.9946700

5.8.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer **Sears Kenmore**

Key to instrumentation:
see appendix B.

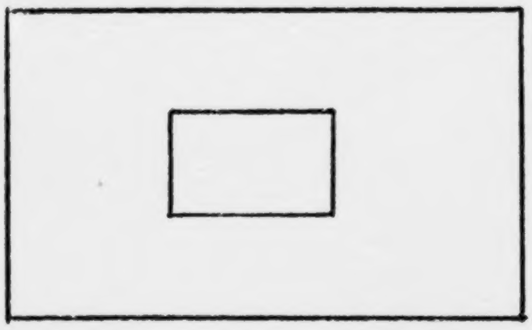
Model **103.9946700**

Serial Number **7268160**

SCHEMATIC OF DOOR AND VIEWING SCREEN

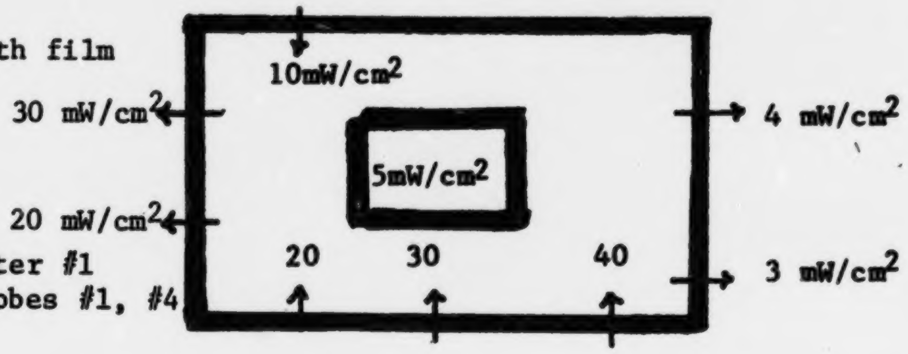
(a) Without film

Meter #1
Probes #1, #4



No leakage greater than 0.5 mW/cm²

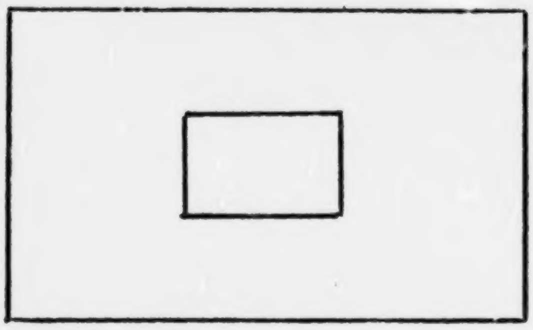
(b) With film



Meter #1
Probes #1, #4

(c) Door opening leakage

Meter #2
Probe #6



Leakage less than 1 mW/cm²

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 610 mW/cm^2 using test method 1 (page 4) and instrument set #2 (appendix B).

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5.9 SEARS-ROPER MODEL 103.9927001 OVEN

5.9.1 Summary

The Sears-Electronic Microwave oven Model 103.9927001 is a countertop oven intended for domestic use. When the door is in the latched closed position, operation is controlled by one rotary timer control.

Two safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is operated by a rotary motion of the door handle. The door cannot be moved until this motion has been accomplished. The other interlock is a reed switch operated by a small magnet located in the door. This interlock does depend on door motion.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a metal-to-metal mesh seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed through the top of the oven, and a three-bladed stirrer is used to distribute the energy. The stirrer operates at 120 revolutions per minute.

One unique feature of this oven is that opposite sides of the same piece of metal serve as the inner cavity walls and as the outer oven surface. This is true for all surfaces except for the top of the oven where the electronics are located.

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5.9.2 Technical Specifications

Manufacturer: Roper

Model: 103.9927001
S/N 9962750

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L-5201

Magnetron output power: 750 W, average 650 minutes

Magnetron lifetime: 750 cycled hours

Magnetron current: 400 mA, maximum 450 mA

Line power requirements: 115V

Type of generator cooling: Air

Inner cavity dimensions: 17 inches by 13-1/4 inches by 9 inches

Controls: One timer dial

Viewing screen type: Metal mesh

Type of door seal: Metal-metal seal silicone rubber tubing covered by double layer or woven monel mesh

Indicators of microwave generator operation: Cooking light

5.9.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Interlock A: Microswitch mounted behind control panel of oven operated by turning latch handle clockwise.

(b) Interlock B: Reed relay mounted behind control panel of oven on level with top edge of door. A fixed permanent magnet located inside the door opens and closes the relay contacts when the door is nearing fully closed position.

(2) Interlock adjustments:

(a) Interlock A: The switch assembly can be slid to a less sensitive position via oblong mounting holes. The switch lever can be bent.

(b) Interlock B: The reed relay may be adjusted vertically or longitudinally rotated.

(3) Door movement for interlock operation:

(a) Interlock A: None: latch moves 5 mm

(b) Interlock B: 28 mm

(4) Worst-case interlock adjustment:

(a) Interlock A: None

(b) Interlock B: Interlock is inoperable

(5) Other door and hinge adjustment: None

(6) Intentional interlock defeating technique:

(a) Interlock A: Can be operated by a straight rod at least one centimeter in length and five millimeters or less in diameter.

(b) Interlock B: Can be operated by placing a small magnet near the bottom edge of the control panel until a soft click is heard, indicating closure of the reed relay.

(7) Door latch description: Spring-loaded rocker arm activated by rotating handle clockwise.

(8) Suggested interlock improvement:

(a) Interlock A should be made less accessible since it can be operated by a straight rod of the dimension stated above.

(b) Interlock B should be mounted so that a much stronger magnet is needed to operate it. Also, the present magnet is very easily demagnetized with the use of a somewhat stronger magnet.

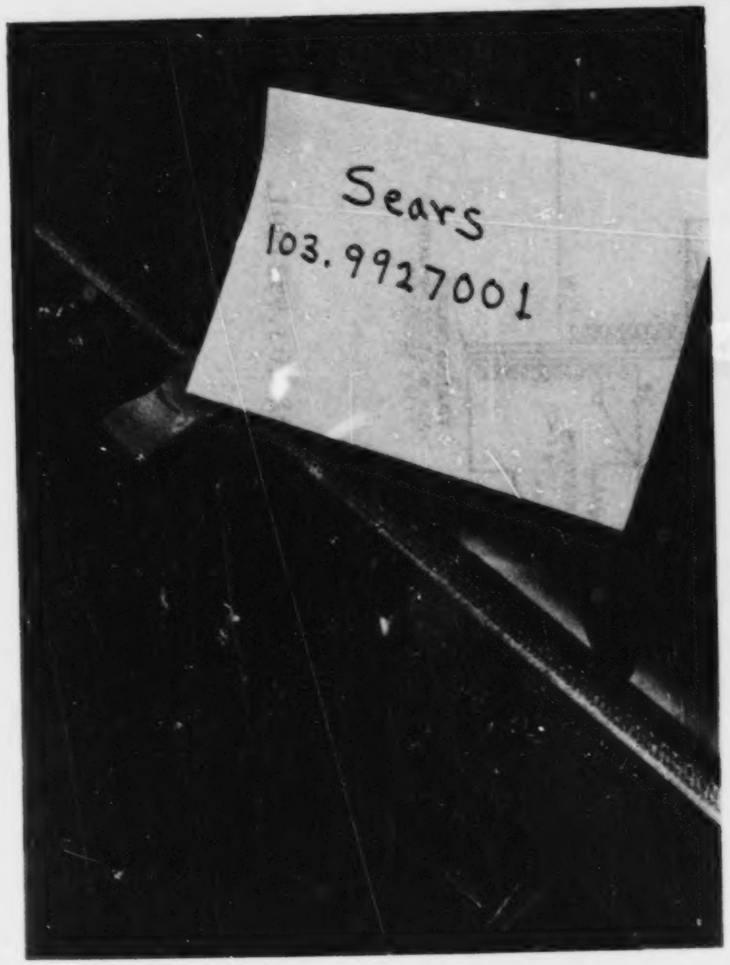

Sears
103.9927001

Figure 28. Sears-Roper Model 103.9927001 door latch which operates interlock A.

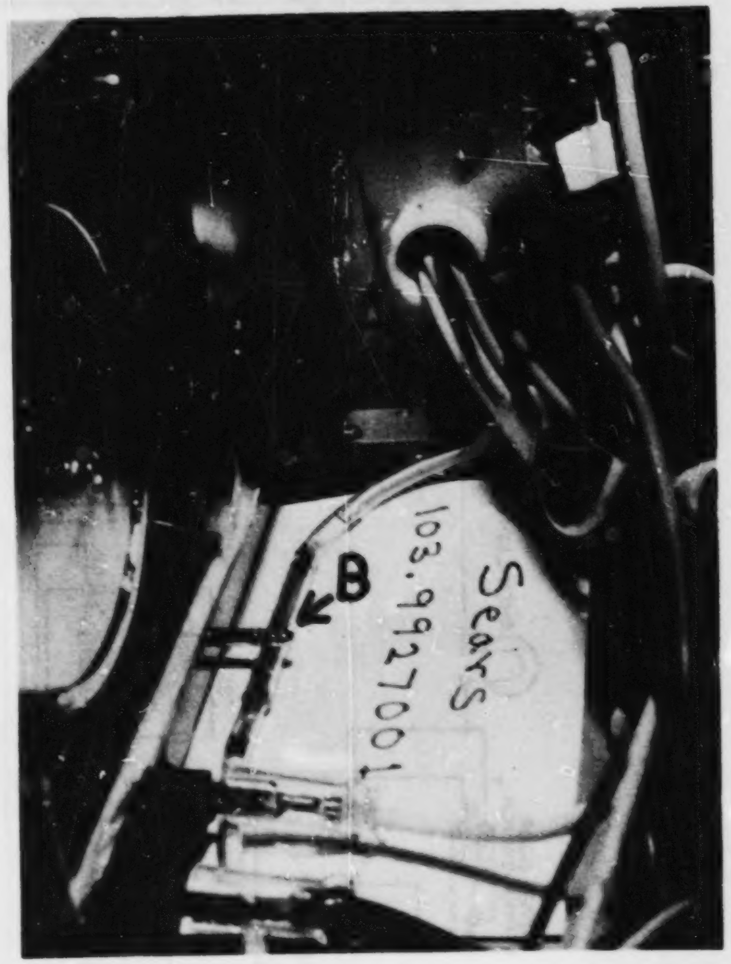

Sears
103.9927001
B

Figure 29. Sears-Roper Model 103.922701 microswitch interlock A, reed switch interlock B.

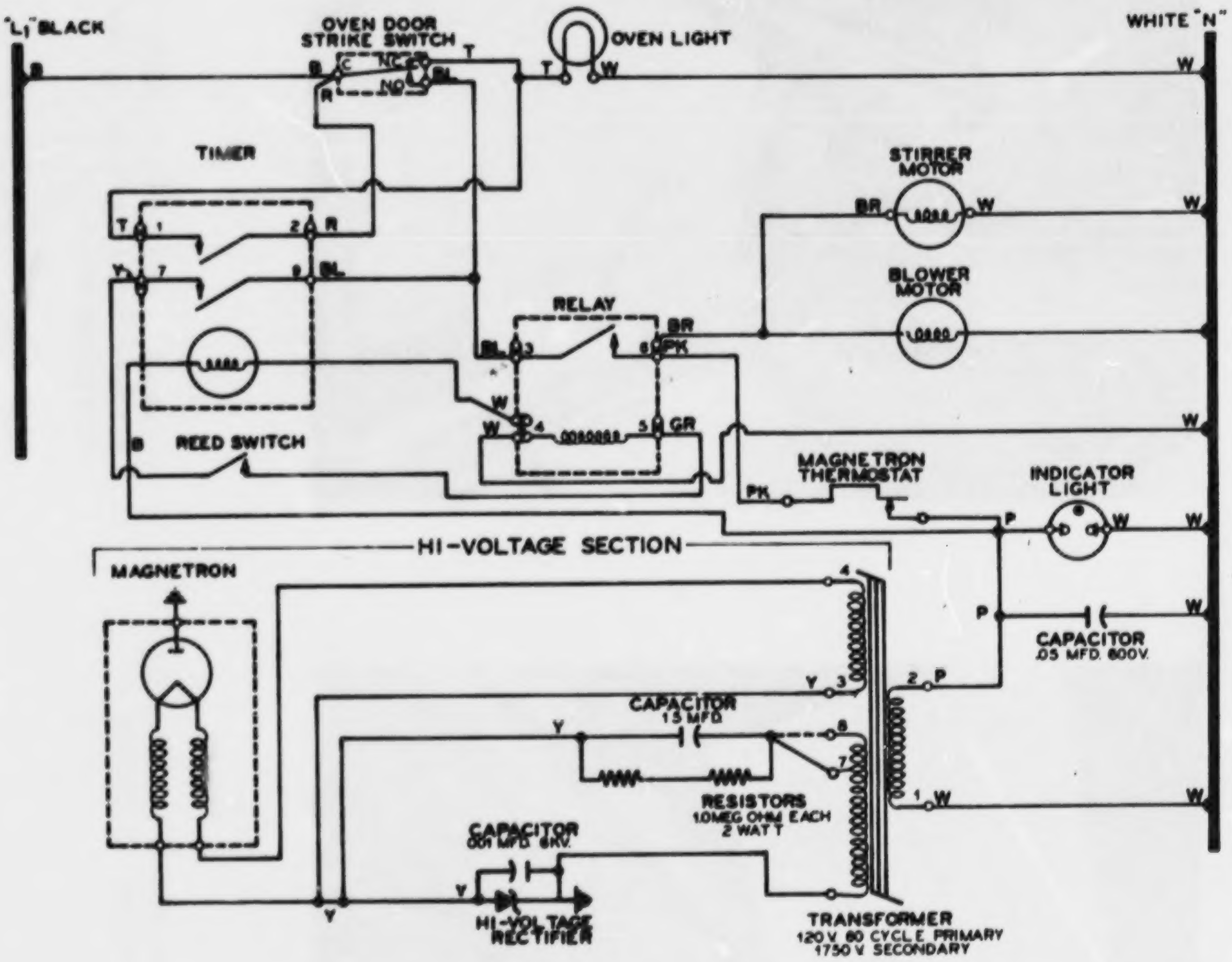

"L1" BLACK
OVEN DOOR STRIKE SWITCH
OVEN LIGHT
WHITE "N"
TIMER
STIRRER MOTOR
BLOWER MOTOR
RELAY
REED SWITCH
MAGNETRON THERMOSTAT
INDICATOR LIGHT
HI-VOLTAGE SECTION
MAGNETRON
CAPACITOR .05 MFD. 600V.
CAPACITOR 1.5 MFD.
RESISTORS 1.0 MEG OHM EACH 2 WATT
CAPACITOR .001 MFD. 6KV.
HI-VOLTAGE RECTIFIER
TRANSFORMER 120 V. 60 CYCLE PRIMARY 1750 V SECONDARY

Figure 30. Schematic of Sears-Roper Model 103.9927001.

5.9.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Roper

Model 103.9927001

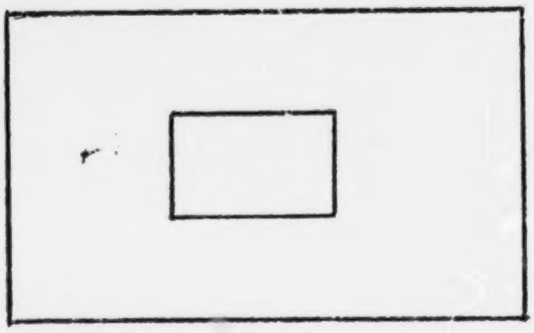
Serial Number 9962750

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

(a) Without film

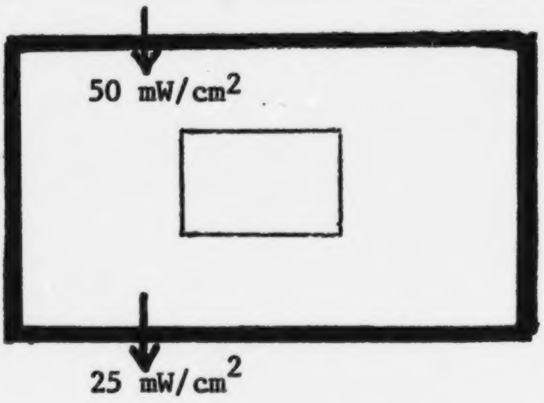
Meter #4
Probes #2, #5



All readings below 0.5 mW/cm^2

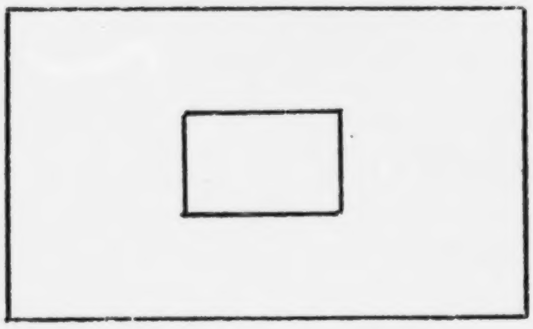
(b) With film

Meter #4
Probes #2, #5



(c) Door opening leakage

Meter #4
Probe #5



All readings below 0.5 mW/cm^2

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 175 mW/cm^2 - 520 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

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5.10 MONTGOMERY WARD SIGNATURE MODEL KTM8090 OVEN

5.10.1 Summary

The Montgomery Ward Signature Electronic Oven Model KTM 8090 is a countertop microwave oven designed for domestic use. The oven has two safety interlock switches to interrupt to interrupt microwave power when the door is opened. One interlock is activated by a thumb-depressed lever before any actual motion of the door occurs. The other interlock is activated by a lever arm connected to the door and depends on door motion for operation.

A choke-type door seal is employed to prevent microwave leakage when the oven is normally operating with the door closed. A laminated viewing screen protected by a clear plastic covering is also incorporated into the door. The door is side hinged and swings open from right to left.

Microwave power is fed into the top of the cavity, and a six-bladed stirrer is used to provide even distribution of power. This stirrer rotates at the rate of 20 revolutions per minute.

The venting of gases from the cavity is accomplished through side wall cavity vents which lead to a rear exit.

Two pushbutton switches and one rotary timer are used to control the oven. A cooking indicator light indicates when microwave power is on.

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5.10.2 Technical Specifications

Manufacturer: Montgomery Ward & Co., Inc.
Electronics by Litton Industries

Model: KTM 8090
Serial No. 2169 MK

Magnetron manufacturer and model: Litton type L-5201

Magnetron output power: 750 W

Magnetron lifetime: 530 cycled hours

Magnetron current: 400 mA

Line power requirements: 115 V

Type of generator cooling: Air

Inner cavity dimensions: 16 inches by 12 inches by 9 inches

Controls: "On - Off" pushbutton, "Press to Cook" pushbutton, and rotary timer control for 0 to 28 minutes of cooking time

Viewing screen type: Plastic-laminated metal screen window

Type of door seal: Choke door seal

Indicators of microwave generator operation: "NOW COOKING" indicator light located on front control panel

5.10.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Interlock A: One microswitch mounted inside front surface of the oven and operated by a thumb-push latch located on door handle. The latch lever arm protrudes from the back side of door 2 cm. The microswitch lever arm is 10 cm long, including two right-angle bends.

(b) Interlock B: One microswitch mounted on bottom of oven chassis and operated by a curved lever arm attached to the door. The activating arm is 25 cm long, and the microswitch lever arm is 10 cm long.

(2) Interlock adjustments:

(a) Interlock A: The switch may be moved slightly in mounting holes. Additionally, the lever arm can be bent.

(b) Interlock B: Same as Interlock A.

(3) Door movement for interlock operation:

(a) Interlock A: None. Latch must be depressed about 2 mm to operate interlock.

(b) Interlock B: 45 mm

(4) Worst-case interlock adjustment:

(a) Interlock A: None. Latch must be depressed 4 mm.

(b) Interlock B. 45 mm

(5) Other door hinge adjustments: None

(6) Intentional interlock defeating technique:

(a) Interlock A can be defeated by using a straight rod 3 mm in diameter and 10 cm long.

(b) Interlock B is inaccessible.

(7) Door latch description: Described in discussion of interlock A in (1) above.

(8) Suggested interlock improvements: Interlock A should be made inaccessible to a straight rod.

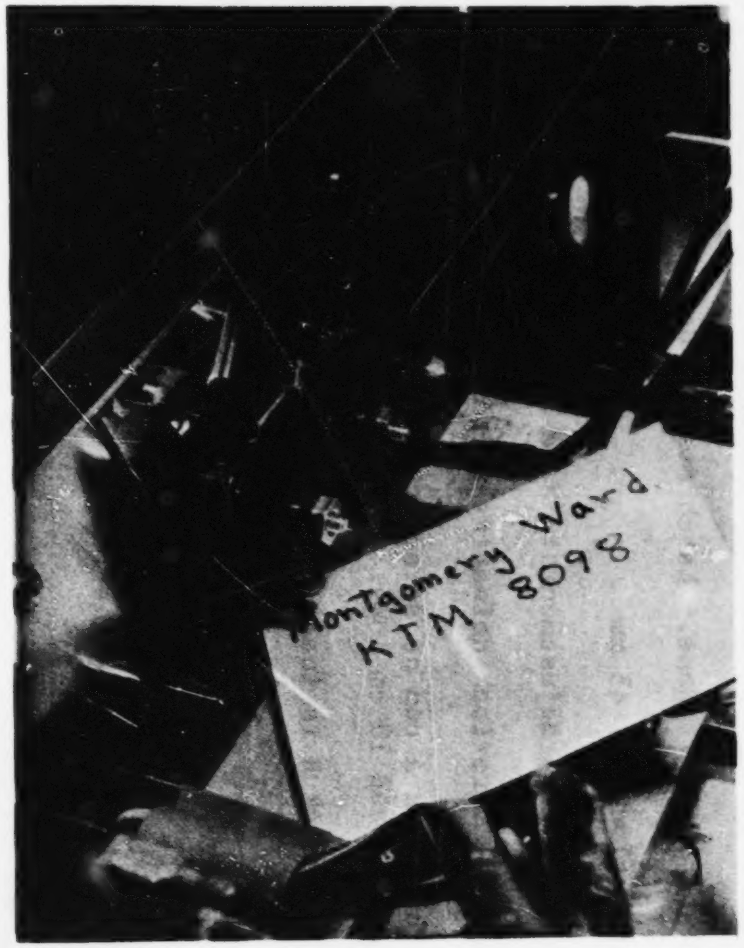

Montgomery Ward
KTM 8098

Figure 31. Montgomery Ward Model KTM 8090 microswitch interlock A.

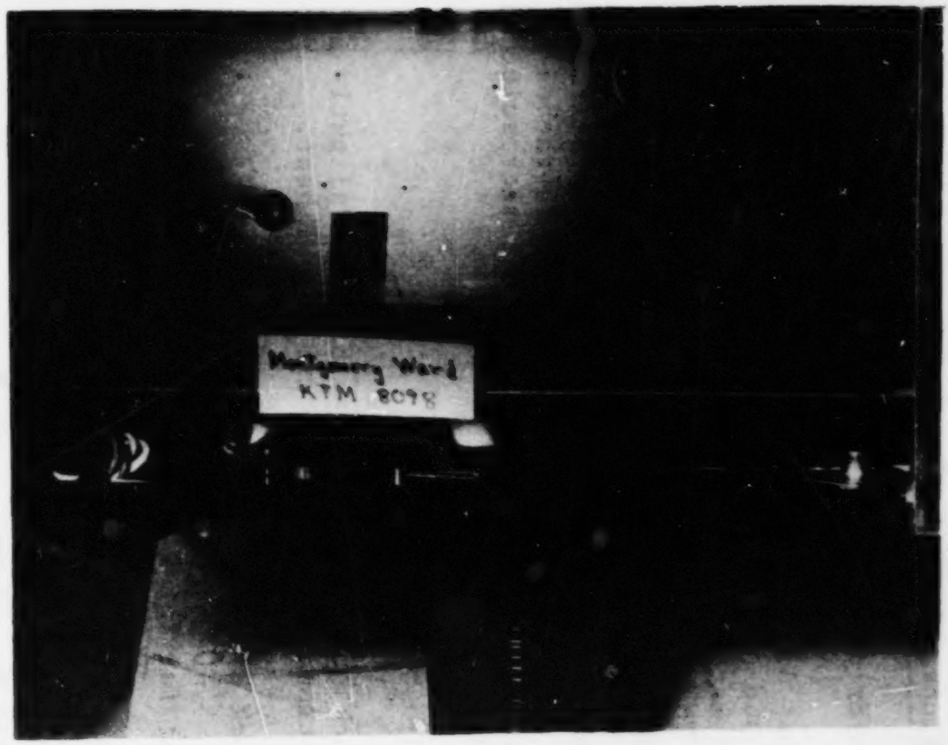

Montgomery Ward
KTM 8098

Figure 32. Montgomery Ward Model KTM 8090 microswitch interlock B.

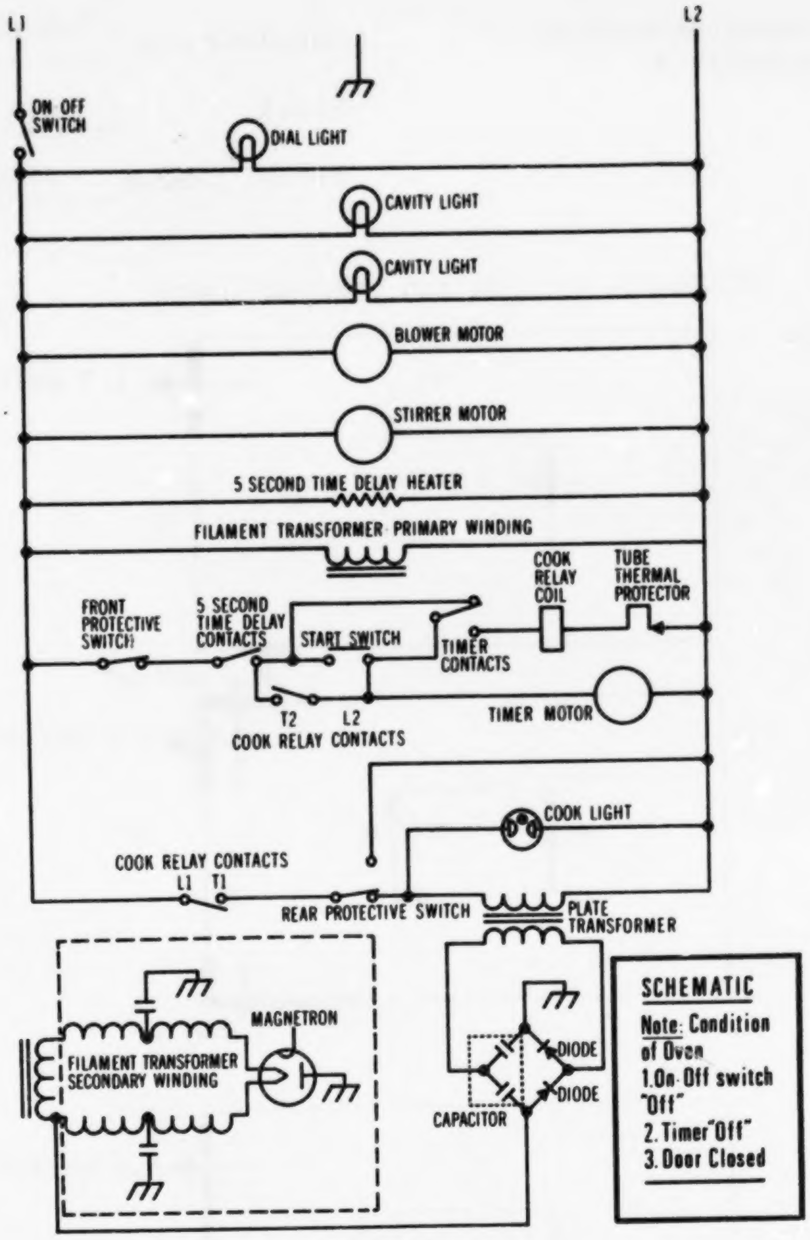

L1
L2
ON OFF SWITCH
DIAL LIGHT
CAVITY LIGHT
CAVITY LIGHT
BLOWER MOTOR
STIRRER MOTOR
5 SECOND TIME DELAY HEATER
FILAMENT TRANSFORMER PRIMARY WINDING
COOK RELAY COIL
TUBE THERMAL PROTECTOR
FRONT PROTECTIVE SWITCH
5 SECOND TIME DELAY CONTACTS
START SWITCH
TIMER CONTACTS
TIMER MOTOR
T2
L2
COOK RELAY CONTACTS
COOK LIGHT
COOK RELAY CONTACTS
L1
T1
REAR PROTECTIVE SWITCH
PLATE TRANSFORMER
MAGNETRON
FILAMENT TRANSFORMER SECONDARY WINDING
DIODE
DIODE
CAPACITOR
SCHEMATIC
Note: Condition of Oven
1.On-Off switch "Off"
2.Timer "Off"
3.Door Closed

Figure 33. Schematic of Montgomery Ward Model KTM-8090.

5.10.4 Microwave Leakage from Door Seals for Three Conditions of Test

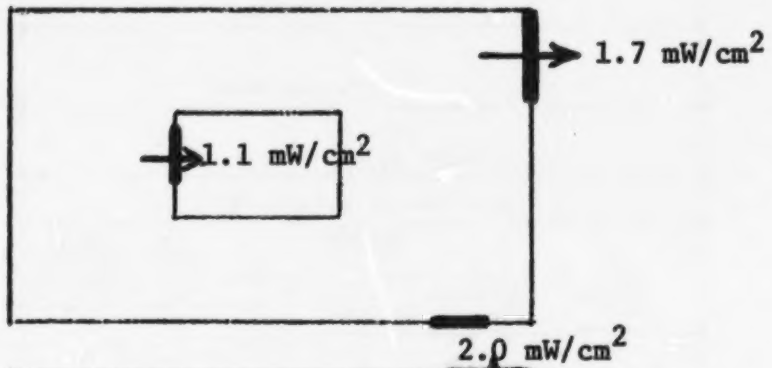
Key to instrumentation:
see appendix B.

Manufacturer Montgomery Ward
Model KTM 8090
Serial Number 2169 MK

SCHEMATIC OF DOOR AND VIEWING SCREEN

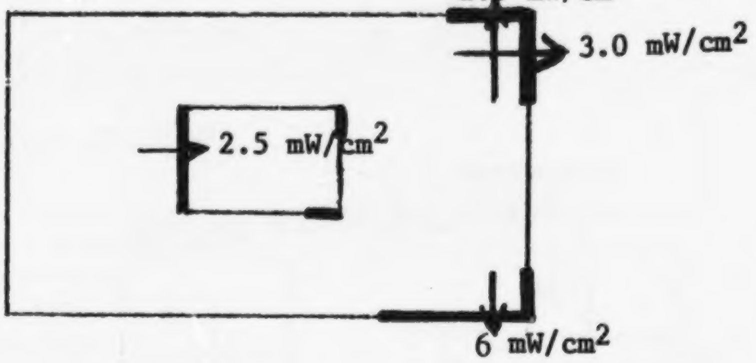
(a) Without film

Meter #2
Probe #8


1.7 mW/cm^2
1.1 mW/cm^2
2.0 mW/cm^2

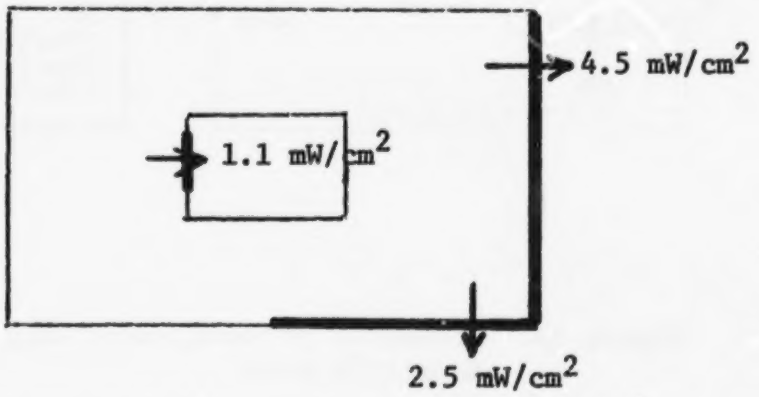
(b) With film

Meter #2
Probe #8


3.0 mW/cm^2
2.5 mW/cm^2
6 mW/cm^2

(c) Door opening leakage

Meter #2
Probe #8


4.5 mW/cm^2
1.1 mW/cm^2
2.5 mW/cm^2

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 340 mW/cm^2 - 1,000 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.11 OMNIVEND MODEL 110D OVEN

5.11.1 Summary

The Omnivend Model 110D microwave oven is a countertop oven designed either for domestic or commercial use. When the door is in the closed position, operation is controlled by five pushbutton timers.

Two safety interlocks are employed to disrupt microwave power when the door is opened. These interlocks are identical except that one is near the top of the oven door and the other is near the bottom. These interlocks employ microswitches mounted so that the lever arm is moved by posts mounted on the oven door. When the door is closed, the posts go through holes in the front panel and operate the microswitches. The operation of these interlocks depends on door motion.

The door is left hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a choke seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the oven through the small holes.

Microwave power is fed into the cavity through the back wall by an antenna. No stirrer is used in this oven.

5.11.2 Technical Specifications

Manufacturer: Ominvend

Model: 110 D

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Amperex Dx 260

Magnetron output power: 700 to 1000 W

Magnetron lifetime: 1000 hours

Magnetron current: 300 mA

Line power requirements: 100 to 120 V a.c.

Type of generator cooling: Air

Inner cavity dimensions: 10 inches by 10 inches by 10 inches

Controls: "Cooking" light, five-pushbutton timer

Viewing screen type: Metal grid

Type of door seal: Choke door seal

Indicators of microwave generator operation: A red "cooking light" indicates that filament and anode voltages are applied to the magnetron.

5.11.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Cabinet interlock: One microswitch mounted at the back of the oven chassis, the lever contacting the cabinet wall.

(b) Door interlock A: Microswitch mounted so that the lever arm is moved by a post mounted near the top of the oven door. When the door is closed, the post goes through a hole in the front panel of the oven and operates the microswitch.

(c) Door interlock B: Same as interlock A, only near the bottom of the oven door.

(2) Interlock adjustments:

(a) Cabinet Interlock: Microswitch mounting holes are large enough so that it can be positioned.

(b) Door interlock A: The mounting bracket may be moved and positioned within the limits of the mounting holes.

(c) Door interlock B: Same as interlock A.

(3) Door movement for interlock operation: When oven arrived, the door would operate the microswitch after moving open about 1 mm.

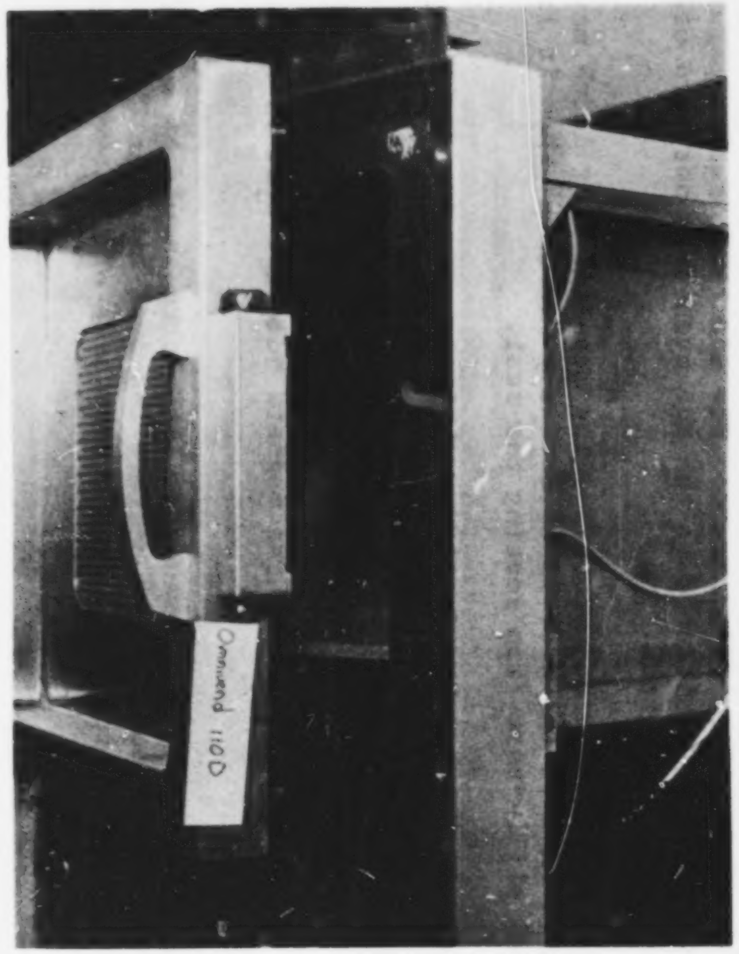
(4) Worst-case interlock adjustments: The mounting bracket permits the switch to be positioned so the the oven does not turn off when the door is opened.

(5) Other door or hinge adjustments: The magnetic door latch may be adjusted so that the door is effectively "latched" when it is several millimeters from seating the seal.

(6) Intentional interlock defeating technique: The two door interlocks may be defeated by inserting two objects 6 millimeters (or less) in diameter into the two holes in the front panel. The oven may then be operated with the door open.

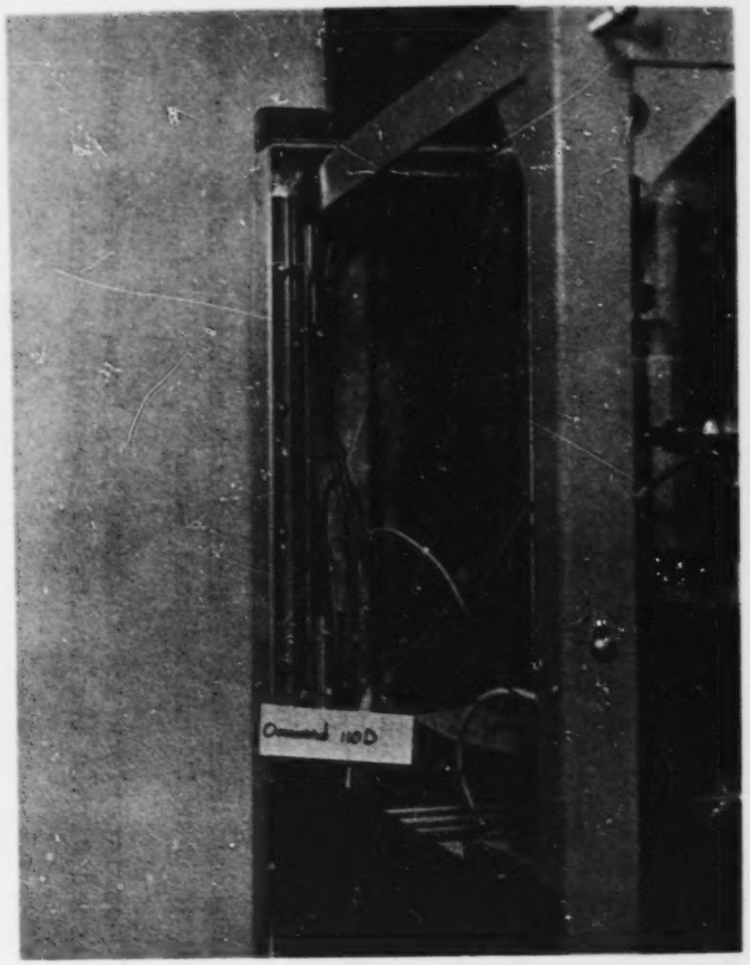
(7) Door latch description: Three magnets hold the door in a closed position.

(8) Suggested interlock improvement: Interlocks should be modified so that it is impossible to operate the oven with the door open by mechanical manipulation from the outside of the oven cabinet.



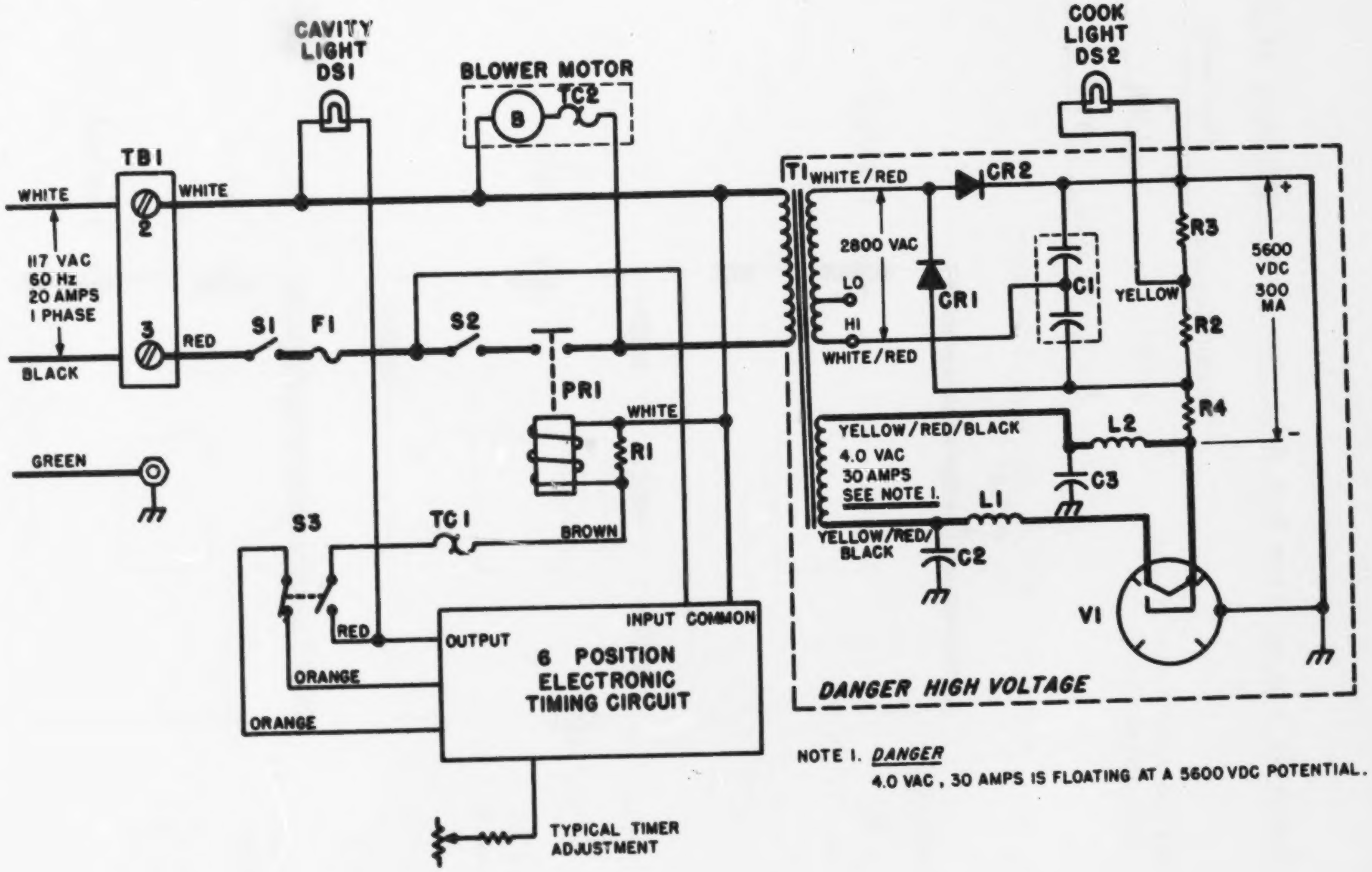
Omnivend 110D

Figure 34. Omnivend Speedrange Model 110D door interlock A mounted behind door panel.



Omnivend 110D

Figure 35. Omnivend Speedrange Model 110D cabinet interlock mounted on back of chassis.


CAVITY LIGHT DS1
BLOWER MOTOR
B
TC2
COOK LIGHT DS2
TB1
WHITE
2
3
117 VAC
60 Hz
20 AMPS
1 PHASE
BLACK
WHITE
RED
GREEN
S1
F1
S2
PR1
WHITE
R1
S3
TC1
BROWN
RED
ORANGE
ORANGE
OUTPUT
INPUT COMMON
6 POSITION ELECTRONIC TIMING CIRCUIT
TYPICAL TIMER ADJUSTMENT
T1
WHITE/RED
2800 VAC
LO
HI
WHITE/RED
CR2
CR1
C1
YELLOW
R3
R2
R4
+
5600 VDC
300 MA
-
YELLOW/RED/BLACK
4.0 VAC
30 AMPS
SEE NOTE 1.
L2
C3
L1
YELLOW/RED/BLACK
C2
V1
DANGER HIGH VOLTAGE

NOTE 1. *DANGER*
4.0 VAC, 30 AMPS IS FLOATING AT A 5600 VDC POTENTIAL.

Figure 36. Schematic of Omnivend Speedrange Model 110D.

5.11.4 Microwave Leakage from Door Seals for Three Conditions of Test

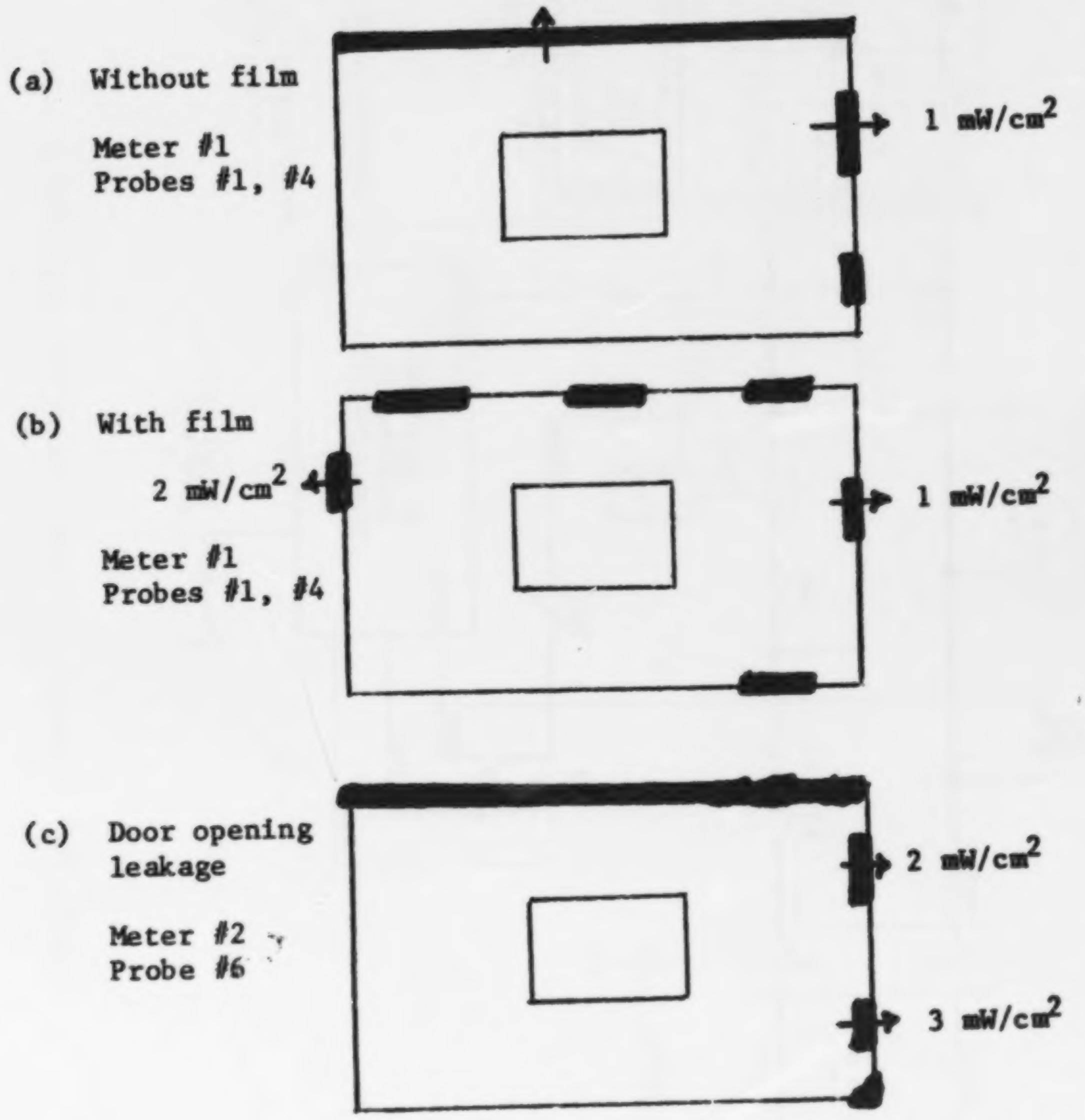
Manufacturer Omnivend

Key to instrumentation: see appendix B.

Model 110D

Serial Number 2125

SCHEMATIC OF DOOR AND VIEWING SCREEN


1 mW/cm²
(a) Without film
Meter #1
Probes #1, #4
1 mW/cm²
(b) With film
2 mW/cm²
1 mW/cm²
Meter #1
Probes #1, #4
(c) Door opening leakage
Meter #2
Probe #6
2 mW/cm²
3 mW/cm²

Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 150 mW/cm^2 - 460 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.12 TAPPAN MODEL R-4A OVEN

5.12.1 Summary

The Tappan Model R-4A microwave oven is designed either for domestic or commercial use. When the oven is in the closed position, operation is controlled by an on-off switch, a rotary timer control, and a "high-low" rotary switch.

One safety interlock is employed to disrupt microwave power when the door is opened. This interlock is a microswitch mounted under a removable plate on the left side of the cabinet. A rod attached to the door closes the switch as the door is closed. The operation of this interlock depends on door motion.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a metal-to-metal pressure door seal is used to eliminate leakage. A viewing screen is located on the door with no protective covering to prevent insertion of objects into the door through the small holes.

Microwave power is fed into the top of the cavity by means of a waveguide, and a stirrer is used to distribute the microwave power. A browning element is also included in the cavity of this oven.

5.12.2 Technical Specifications

Manufacturer: Tappan

Model: R-4A

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Litton L5001

Magnetron output power: 1000W

Magnetron lifetime: 3 to 5 years

Magnetron current: 290 to 325 mA d.c., 240 mA on low

Line power requirements: 118/236 V, 3-wire single-phase, 37.5A maximum

Type of generator cooling: Liquid: 1/3 Atlas Permaguard and 2/3 distilled water

Inner cavity dimensions: 12 inches by 18 inches by 14 inches

Controls: "On-off" switch, browner timer, microwave timer, "Hi-Lo" switch

Viewing screen type: Metal screen mesh

Type of door seal: Metal-metal pressure seal

Indicators of microwave generator operation: A pilot light indicates power is on

5.12.3 Safety Interlock Evaluation

(1) Interlock description: One interlock exists, a simple push-button switch mounted under a removable plate in the left side of the cabinet. A rod attached to the oven door closes the switch as the oven door is closed.

(2) Interlock adjustments: Switch mount may be swiveled in elongated mounting holes. Switch may be removed from mounting bracket to the limit of its electrical leads.

(3) Door movement for interlock operation: Oven turns off after door opens 7 mm.

(4) Worst-case interlock adjustment: 7 mm.

(5) Other door hinge adjustments: None.

(6) Intentional interlock defeating technique: The interlock can be defeated by removing the small plate which hides the switch and then tripping the switch by hand.

(7) Door latch description: Operates on spring tension.

(8) Suggested interlock improvements: Adjustments to the present interlock should be minimized, and an additional interlock should be installed.

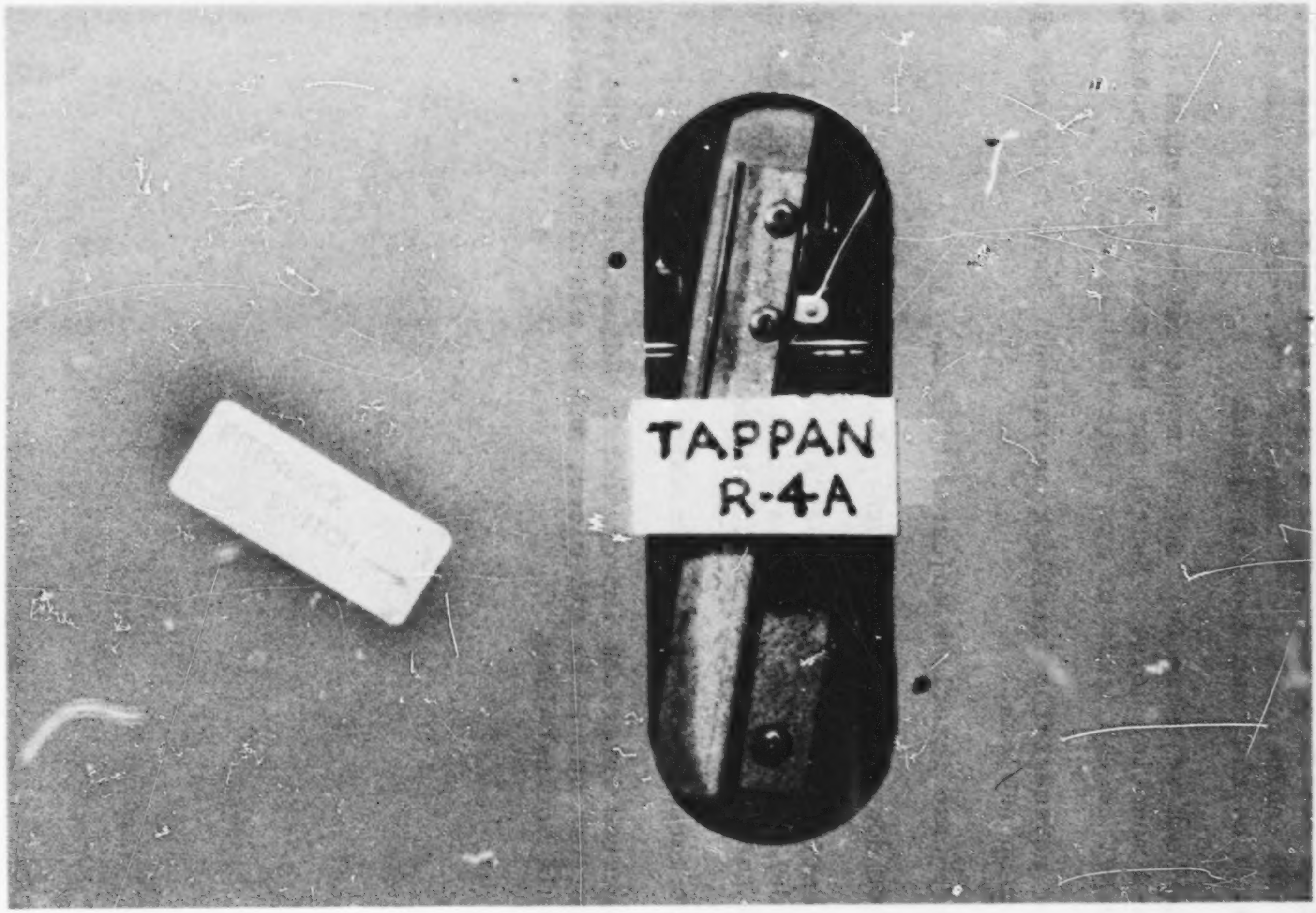


Figure 37. Tappan Model R-4A door interlock.

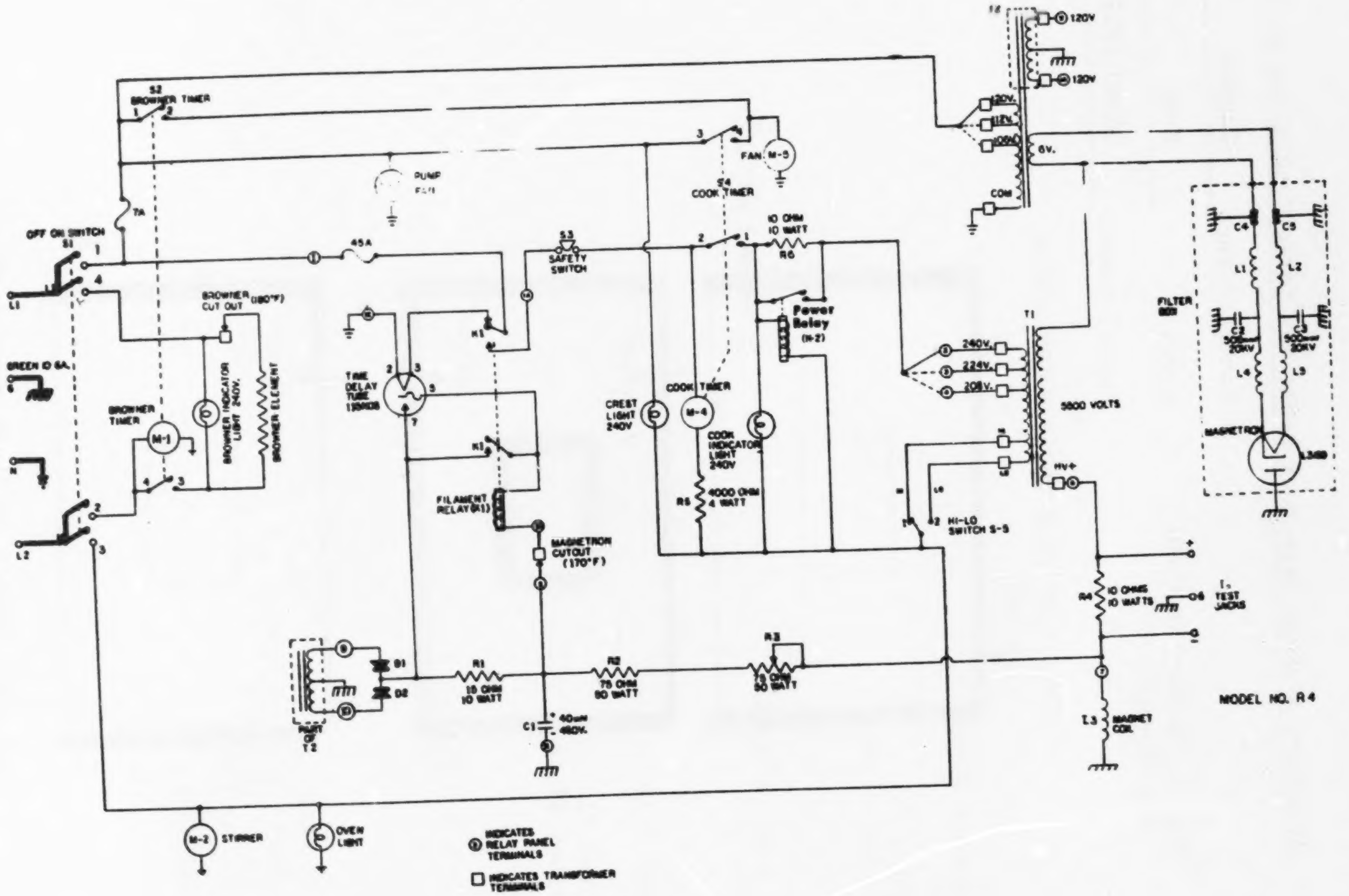

S2
BROWNER TIMER
OFF ON SWITCH
S1
L1
L2
GREEN ID 6A.
N
7A
45A
PUMP
FAN
BROWNER CUT OUT (180°F)
BROWNER INDICATOR LIGHT 240V.
BROWNER ELEMENT
BROWNER TIMER
M-1
S3
SAFETY SWITCH
K1
TIME DELAY TUBE
FILAMENT RELAY (K1)
MAGNETRON CUTOUT (170°F)
PART OF T2
D1
D2
R1
10 OHM 10 WATT
R2
75 OHM 50 WATT
R3
75 OHM 50 WATT
C1
40uf 450V.
M-2
STIRRER
OVEN LIGHT
INDICATES RELAY PANEL TERMINALS
INDICATES TRANSFORMER TERMINALS
FAN
M-5
S4
COOK TIMER
10 OHM 10 WATT
R6
Power Relay (K-2)
CREST LIGHT 240V
COOK TIMER
M-4
COOK INDICATOR LIGHT 240V
R5
4000 OHM 4 WATT
T2
120V
120V
120V.
112V.
100V.
6V.
COM
T1
240V.
224V.
208V.
5500 VOLTS
HI
LO
HV+
HI-LO SWITCH S-5
R4
10 OHMS 10 WATTS
Ia TEST JACKS
+
-
L3
MAGNET COIL
MODEL NO. R 4
FILTER
C4
C5
L1
L2
C2
500mmf 20KV
C3
500mmf 20KV
L4
L3
MAGNETRON
L389

Figure 38. Schematic of Tappan Model R-4A.

5.12.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Tappan

Key to instrumentation: see appendix B.

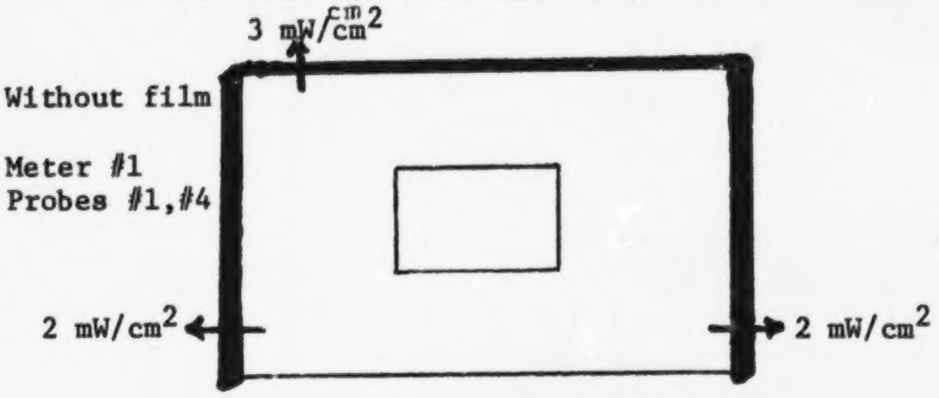
Model R-4A

Serial Number 04190-1828-2590

SCHEMATIC OF DOOR AND VIEWING SCREEN

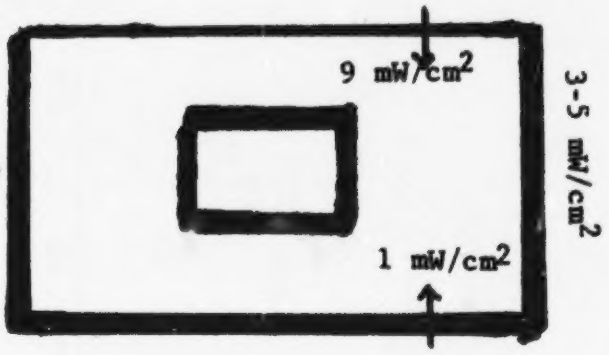
(a) Without film

Meter #1
Probes #1,#4



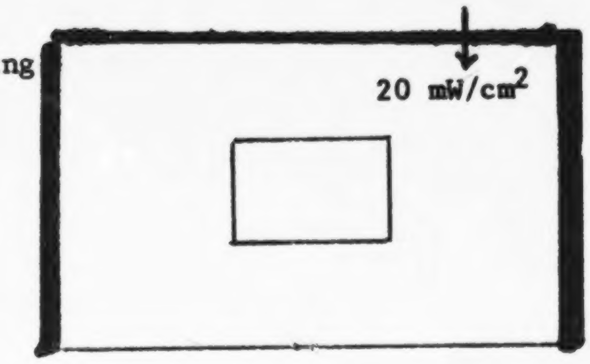
(b) With film

Meter #1
Probes #1,#4



(c) Door opening leakage

Meter #2
Probe #6



Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 640 mW/cm^2 using test method 1 (page 4) and instrument set #2 (appendix B).

5.13 TOSHIBA MODEL ER-602B OVEN

5.13.1 Summary

The Toshiba Microwave Oven, Model ER-602B, is a countertop unit designed for domestic use. When the door is fully closed, the oven is controlled by one "on-off" rocker arm switch, a "cooking" push-button switch, and a rotary timer control.

The oven has two interlocks designed to disrupt power when the door is being opened. One interlock is operated by a lever extending from the door through the front surface of the oven. The other interlock is operated by the door itself which strikes a plunger extending through the oven front surface from the interlock lever arm.

The door of the oven is bottom hinged and opens a full 90 degrees. A choke seal is designed into the door to prevent leakage when the door is closed and the oven is operating normally. A large viewing screen is also designed into the door. This viewing has no protective covering to prevent the insertion of small objects into the oven cavity through the small holes. Venting of gases from the oven is accomplished through the front viewing screen.

Microwave power enters the cavity through the top and is distributed in the oven by a four-bladed stirrer. This stirrer rotates at 120 revolutions per minute.

5.13.2 Technical Specifications

Manufacturer: Toshiba

Model: 602B

Operating frequency: 2450 MHz

Magnetron manufacturer and model: Toshiba M4545B

Magnetron output power: 600W

Magnetron lifetime: 3000 hours

Magnetron current: 300 mA

Line power requirements: 115V

Type of generator cooling: Air

Inner cavity dimensions: 7-7/8 inches by 13 inches x 9-7/8 inches

Controls: On/off switch, microwave power switch, timer knob

Viewing screen type: Metal screen

Type of door seal: Choke

Indicators of microwave generator operation: Pilot light and depressed control

5.13.3 Safety Interlock Evaluation

(1) Interlock description:

(a) Door interlock A: One microswitch mounted behind the oven door frame triggered by plunger which protrudes through the frame. The plunger is pushed by the oven door.

(b) Door interlock B: One microswitch mounted on outside of oven cavity inside chassis. The switch is triggered by an 8-inch shaft attached to oven door.

(2) Interlock adjustments: Switch lever arms of interlocks A and B may be bent and the switch mounting brackets may be positioned by moving the mounting screws in oblong holes.

(3) Door movement for interlock operation:

(a) Interlock A: 2 mm

(b) Interlock B: 8 mm

(4) Worst-case interlock adjustments:

(a) Interlock A: Oven door can be opened completely without turning oven off.

(b) Interlock B: Same as interlock A.

(5) Other door or hinge adjustments: None

(6) Intentional interlock defeating technique:

(a) Interlock A may be operated by pressing plunger with finger.

(b) Interlock B cannot be operated with door open and cabinet in place.

(7) Door latch description: None

(8) Suggested interlock improvements: Interlock adjustments should be modified to insure oven will not operate with door open.

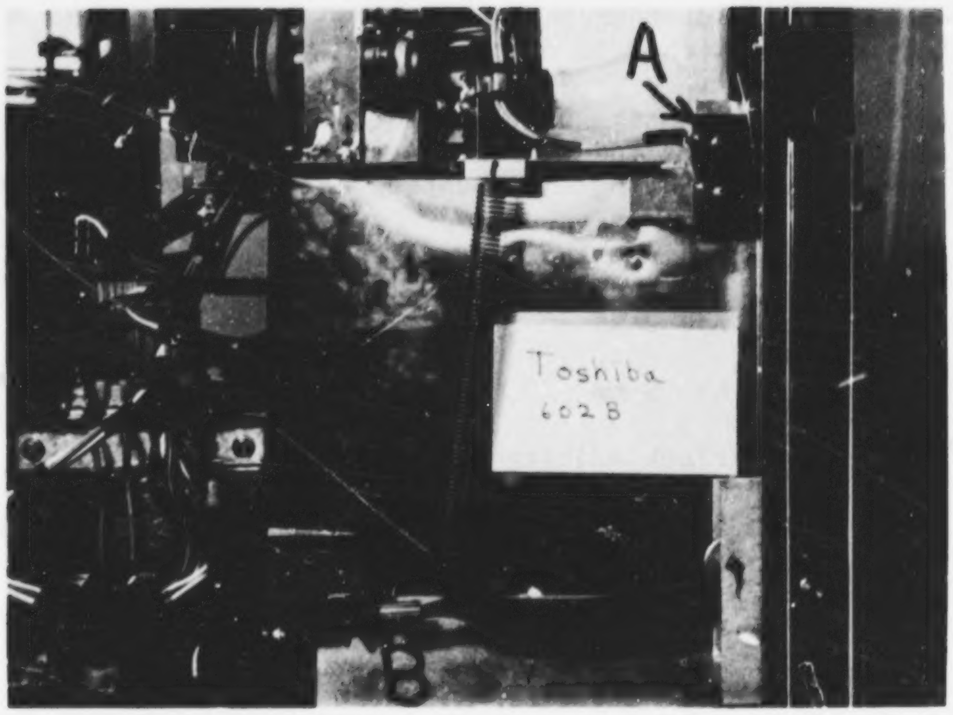

A
Toshiba
602B
B

Figure 39. Toshiba Model ER-602B microswitch interlocks A and B.

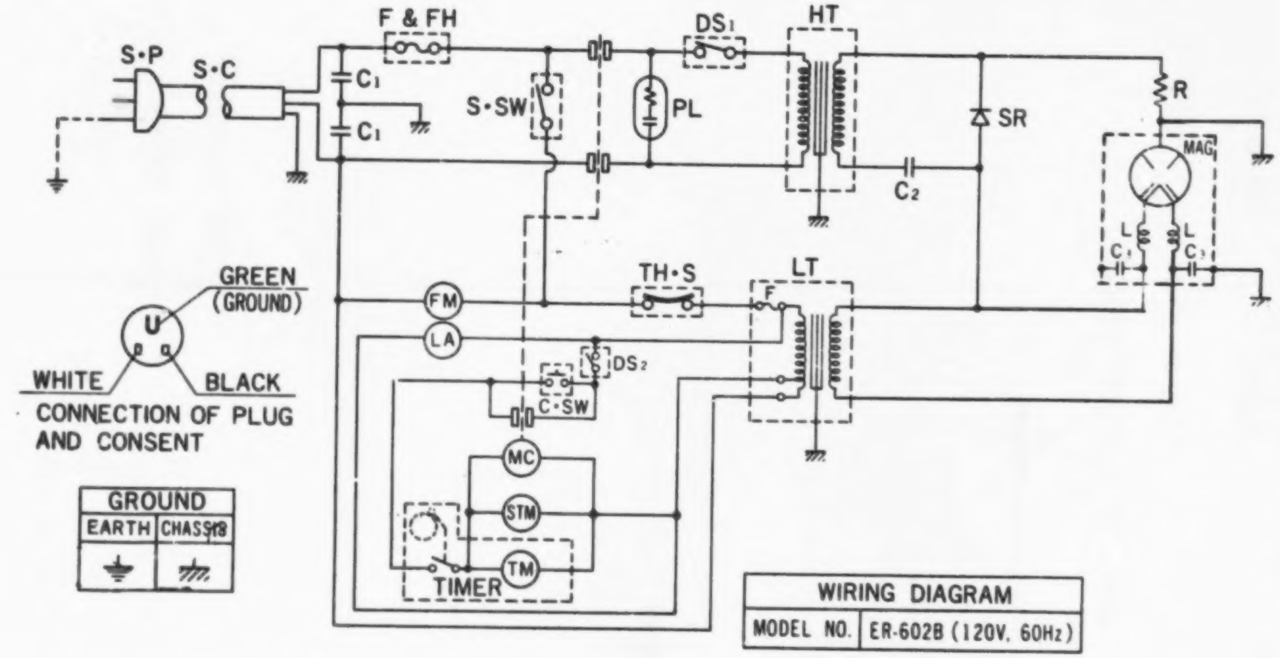

S·P
S·C
F & FH
C₁
C₁
S·SW
DS₁
PL
HT
C₂
SR
R
MAG
L
L
C₁
C₁
TH·S
LT
F
FM
LA
DS₂
C·SW
MC
STM
TM
TIMER
GREEN
(GROUND)
U
WHITE
BLACK
CONNECTION OF PLUG
AND CONSENT
GROUND
EARTH
CHASSIS
WIRING DIAGRAM
MODEL NO.
ER-602B (120V, 60Hz)

Figure 40. Schematic of Toshiba Model ER-602B.

5.13.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer Toshiba

Model ER-602B

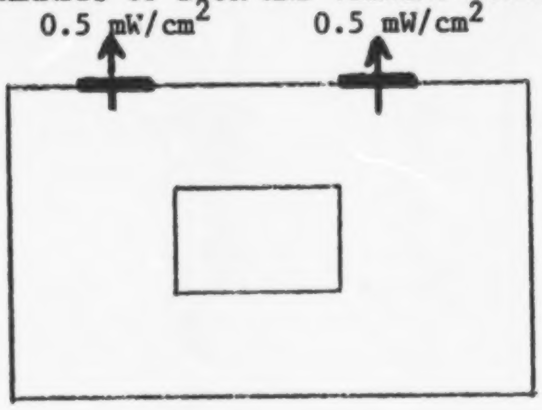
Serial Number 9080892

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR AND VIEWING SCREEN

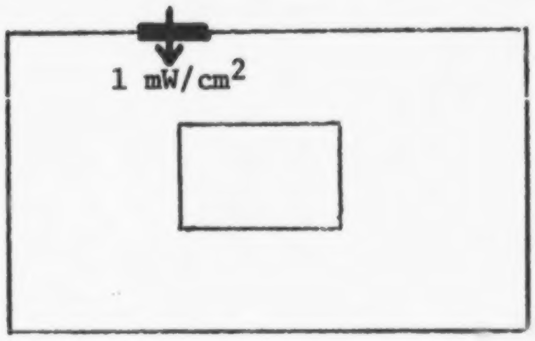
(a) Without film

Meter #4
Probes #3, #7



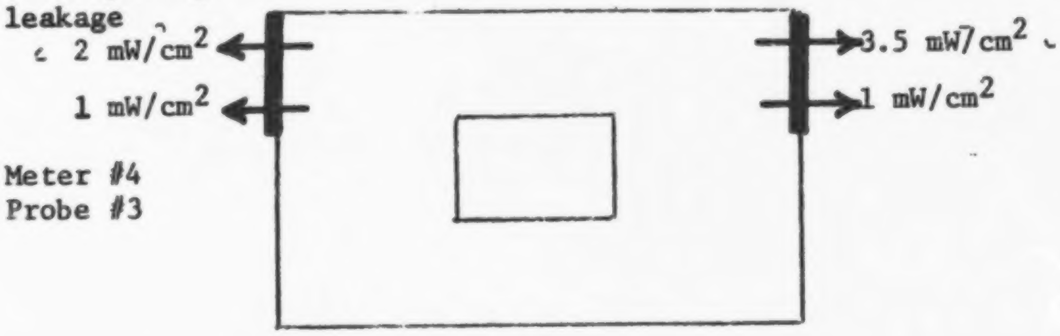
(b) With film

Meter #4
Probes #3, #7



(c) Door opening leakage

Meter #4
Probe #3



Shaded areas denote readings above 1 mW/cm^2.
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 220 mW/cm^2 - 650 mW/cm^2 using test method 2 (page 4) and instrument set #1 (appendix B).

5.14 GENERAL ELECTRIC MODEL JE896E1 OVEN

5.14.1 Summary

The General Electric Versatronic Model JE896E1 oven is designed for domestic use and operates at a frequency of 915MHz. This unit is a double oven with the microwave portion being incorporated into the lower oven. When the door is in the latched closed position, operation is controlled by a high-low power rotary switch and a rotary timer switch.

Two safety interlocks are employed to disrupt microwave power when the door is opened. One interlock is a microswitch mounted on the back of the oven and operated by an oven door latching mechanism on the front. This latching mechanism must be operated before any door motion occurs; therefore, the operation of the microswitch does not depend on door motion. The other interlock is a momentary contact switch whose plunger contacts the door directly. If the first interlock fails to operate, this second interlock causes a fuse to fail which then requires oven servicing.

The door is bottom hinged and opens a full 90 degrees. When the door is closed and the oven is operating normally, a metal-to-metal mesh seal is used to eliminate leakage. No viewing screen is located on the door of this oven.

Microwave power is fed to the oven by means of an antenna through the back of the cavity. The food is placed on a rotating table which is rotated through the microwave field.

5.14.2 Technical Specifications

Manufacturer: General Electric

Model: P7 Versatronic, JE 896E1WH

Operating frequency: 915 MHz

Magnetron manufacturer and model: G.E. J 300

Magnetron output power: 700 W on "Hi"
150 W on "Lo"

Magnetron lifetime: 2 years

Magnetron current: Data not available

Line power requirements: 208/240 V a.c.

Type of generator cooling: Air

Inner cavity dimensions: 18 inches by 21 inches by 15-1/2 inches

Controls: "On-Off" "Hi-Lo" dial; timer dial, latch release button, "Open-latched" switch

Viewing screen type: None, solid metal door

Type of door seal: Metal-metal pressure seal and capacitive seal which uses air as a dielectric

Indicators of microwave generator operation: Pilot lights indicating "oven readiness" and "microwave power on."

5.14.3 Safety Interlock Evaluation

(1) Interlock description

(a) Door interlock A: One momentary contact switch whose plunger contacts the door directly.

(b) Door interlock B: Microswitch mounted on back of oven operated by an oven door latching mechanism on the front of the stove.

(2) Interlock adjustments:

(a) Adjustments to interlock A: none

(b) Adjustments to interlock B: none

(3) Door movement for interlock operation:

(a) Interlock A: Plunger travel from extended position to switch point - 1 mm. Non-hysteresis switch; i.e., on and off occur at same point of plunger travel. If interlock B should fail, causing interlock A to operate, then the operation of A caused a fuse to fail and oven then requires servicing.

(b) Interlock B: Oven latch movement necessary to turn switch on and off - 13 millimeters (near the fully latched end of the lever slide which is about 120 millimeters long). The lever cannot be moved without engaging another pushbutton switch momentarily to mechanically free the lever.

(4) Worst-case interlock adjustments: Since interlocks do not depend on door movement, magnetron power is shut off before door can be opened at all.

(5) Other door or hinge adjustments: None

(6) Intentional interlock defeating technique: To operate the oven with open door, the following steps were used:

(a) Push latch-release button and begin sliding latch to the right.

(b) When latch stops about halfway across, release the catch which is sticking out just below the lever and slide the lever all the way to the right.

(c) Hold in the pushbutton switch on the left side of the oven opening.

(d) Set the electronic timer and turn the power on to "high" or "low".

(7) Door latch description: Described above.

(8) Suggested interlock improvements: At least one interlock should be concealed so operation with door open is not possible.

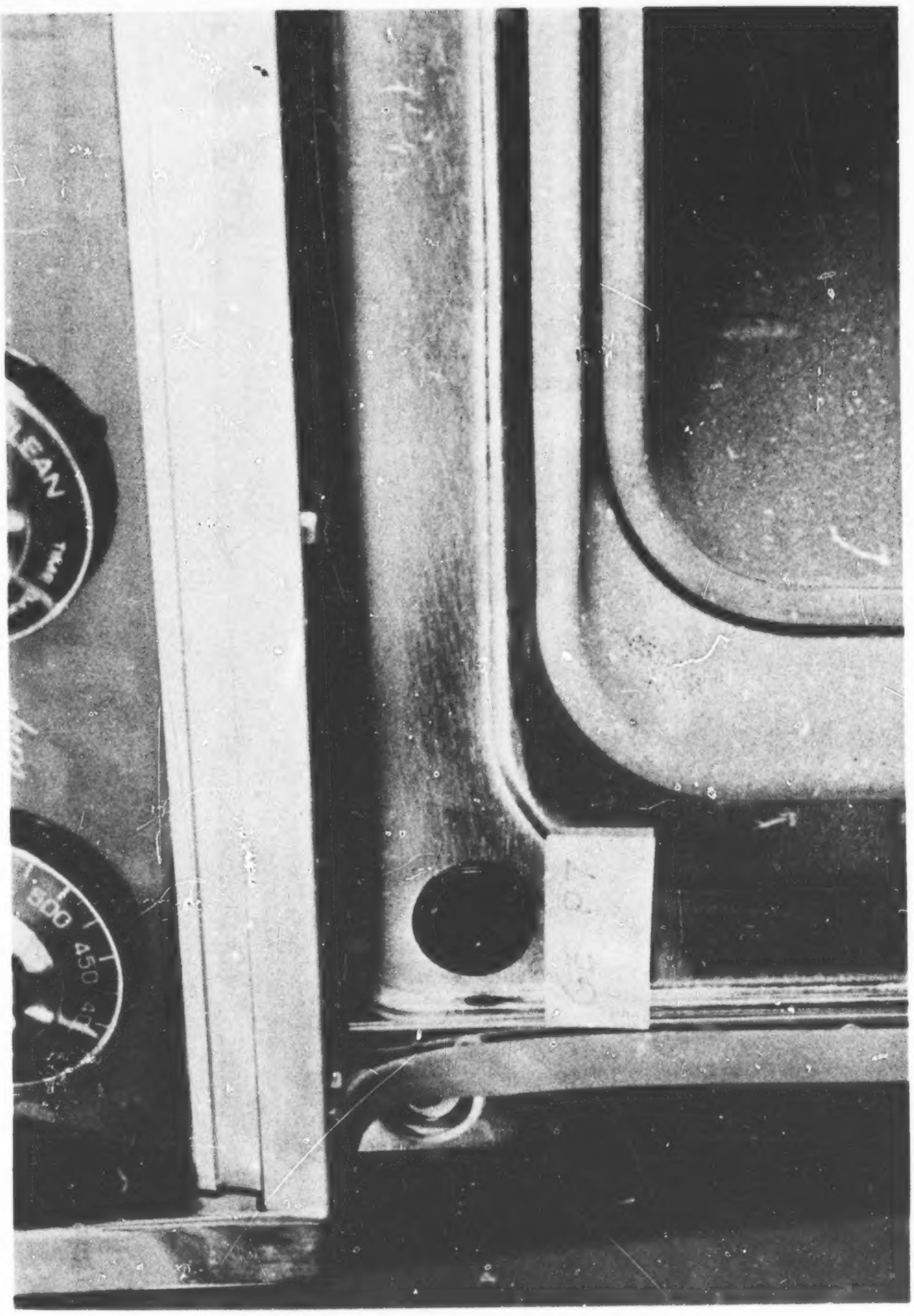

CLEAN
500
450

Figure 41. General Electric Model JE896E1 interlock A mounted on door frame.

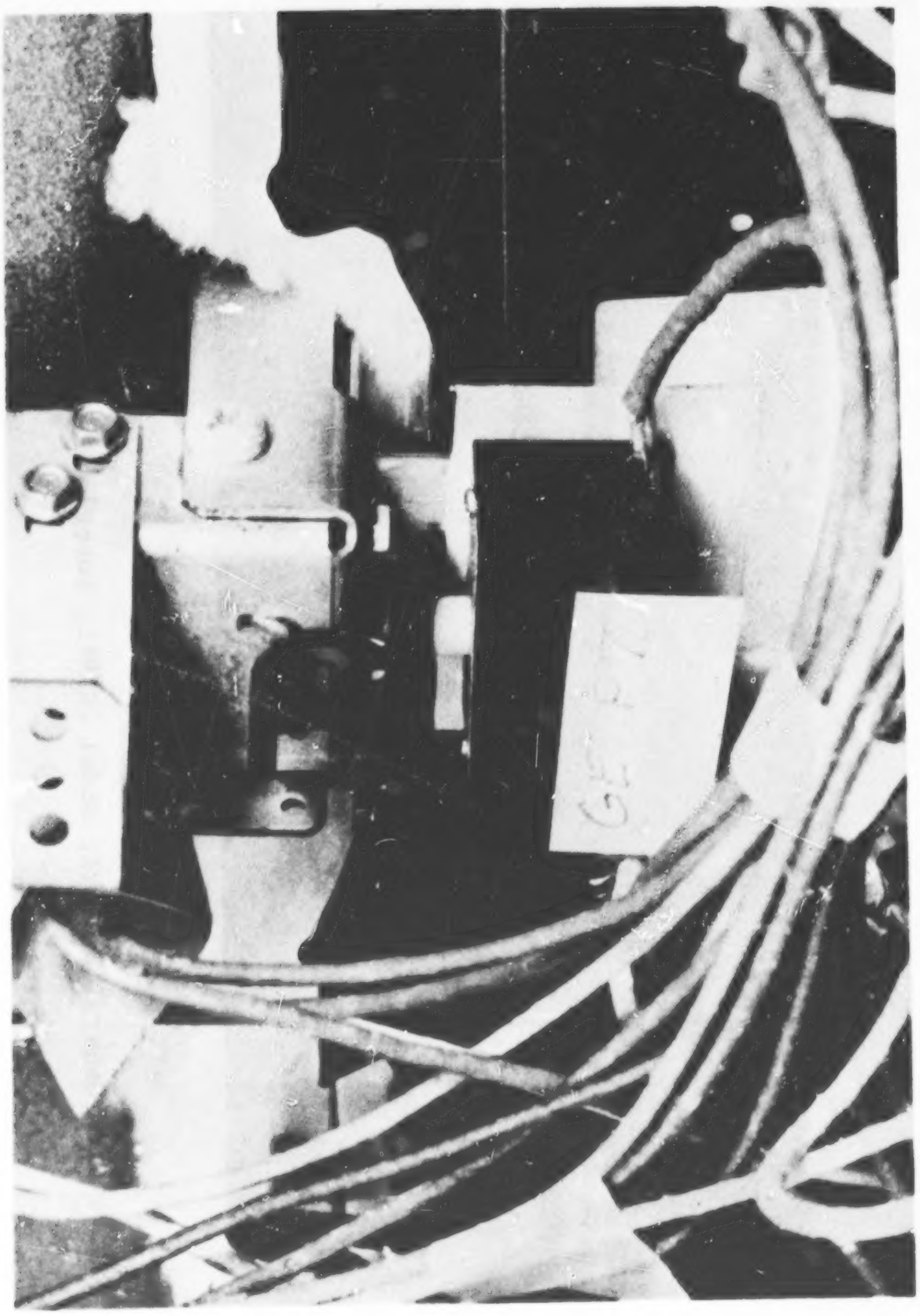


Figure 42. General Electric Model JE896E1 interlock B mounted on back of oven, operated by latch on front of stove.

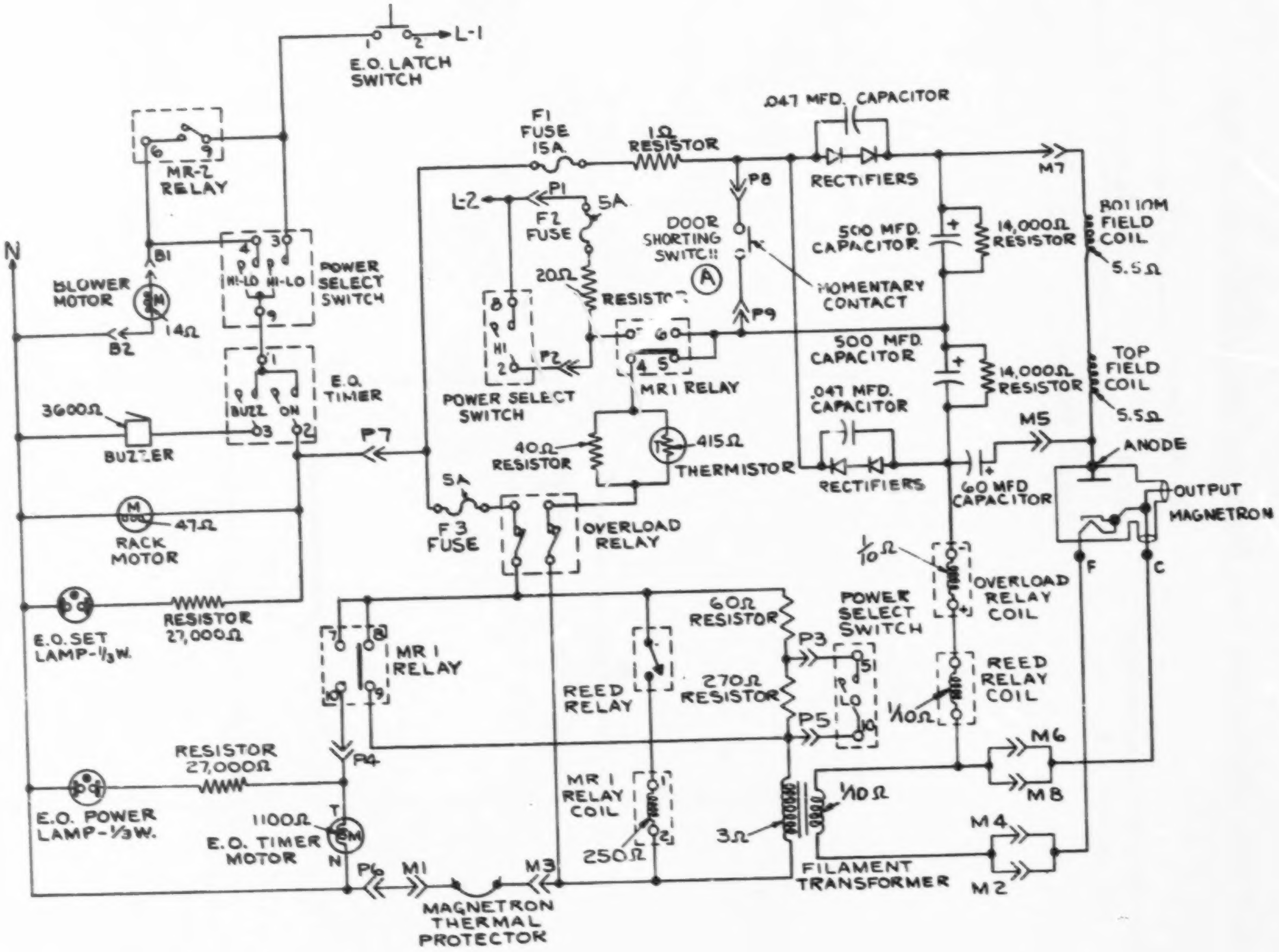

E.O. LATCH SWITCH
L-1
1
2
MR-2 RELAY
6
9
N
B1
B2
BLOWER MOTOR
14Ω
POWER SELECT SWITCH
4
3
HI-LO
HI-LO
9
E.O. TIMER
1
BUZZ
ON
3
2
3600Ω
BUZZER
RACK MOTOR
47Ω
E.O. SET LAMP-1/3W.
RESISTOR 27,000Ω
P7
F1 FUSE 15A
1Ω RESISTOR
L-2
P1
5A
F2 FUSE
20Ω
RESISTOR
8
HI
2
P2
POWER SELECT SWITCH
DOOR SHORTING SWITCH
A
P8
P9
MOMENTARY CONTACT
6
4
5
MR1 RELAY
40Ω RESISTOR
415Ω
THERMISTOR
5A
F3 FUSE
OVERLOAD RELAY
.047 MFD. CAPACITOR
RECTIFIERS
M7
500 MFD. CAPACITOR
14,000Ω RESISTOR
BOTTOM FIELD COIL
5.5Ω
500 MFD. CAPACITOR
14,000Ω RESISTOR
TOP FIELD COIL
5.5Ω
.047 MFD. CAPACITOR
M5
ANODE
RECTIFIERS
60 MFD CAPACITOR
OUTPUT
MAGNETRON
F
C
1/10Ω
OVERLOAD RELAY COIL
POWER SELECT SWITCH
60Ω RESISTOR
P3
270Ω RESISTOR
P5
51
ILO
10
REED RELAY COIL
1/10Ω
REED RELAY
MR 1 RELAY
7
8
10
9
M6
MB
RESISTOR 27,000Ω
P4
E.O. POWER LAMP-1/3W.
1100Ω
T
E.O. TIMER MOTOR
N
P6
M1
M3
MAGNETRON THERMAL PROTECTOR
MR 1 RELAY COIL
250Ω
3Ω
1/10Ω
FILAMENT TRANSFORMER
M4
M2

Figure 43. Schematic of General Electric Model JE896E1.

5.14.4 Microwave Leakage from Door Seals for Three Conditions of Test

Manufacturer G.E.

Model P7 Versatronic

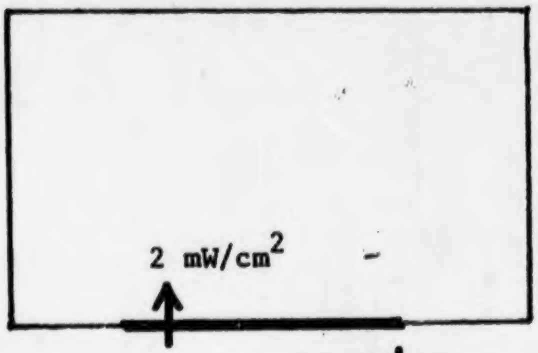
Serial Number DEE 00056

Key to instrumentation:
see appendix B.

SCHEMATIC OF DOOR

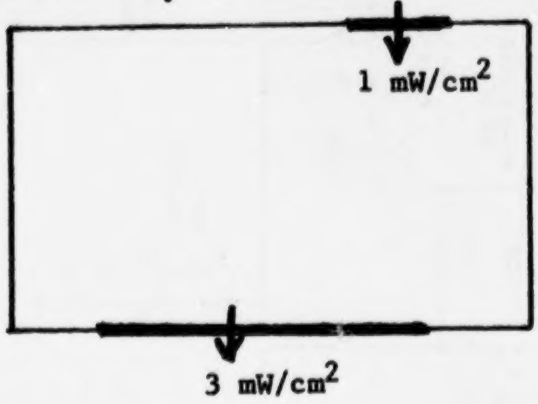
(a) Without film

Meter #3
Probe #3



(b) With film

Meter #3
Probe #3



(c) Door opening leakage

Meter #2
Probe #6

No leakage. Magnetron must be disconnected before door will open.

Shaded areas denote readings above 1 mW/cm^2
Maxima are noted.

(d) Power density at 30 cm with interlocks defeated and door fully open: 150 mW/cm^2 using test method 1 (page 4) and instrument set #2 (appendix B).

APPENDIX A

NARDA 8100 SURVEY PROCEDURE*

*This excerpt from the Narda Microline® Instruction Manual, Interim Operating Instruction for Model 8100 Electromagnetic Radiation Survey Meter, is reprinted with the permission of the Narda Microwave Corporation, Plainview, L.I., N.Y.

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SECTION II

OPERATION

2-1. GENERAL.

2-2. This section provides the functional control description, operating instructions and precautions for the Model 8100 ELECTROMAGNETIC RADIATION SURVEY METER.

2-3. PRELIMINARY INSPECTION.

2-4. This unit was tested and inspected at the factory before shipment. Immediately after unpacking the equipment visually inspect it for damage which may have occured in transit, such as broken knobs, damaged meters, etc. If there is any evidence of damage, immediately file claim for damage to transit with the carrier.

2-5. CONTROL PANEL DESCRIPTION. (See figure 2-1.)

2-6. FRONT PANEL. Table 2-1 provides a complete functional description of all front panel controls.

Table 2-1

Front Panel Control and Indicator Functional Description

Figure 2-1 Index No.	Control	Function
1.	AC cable Plug Connector	Provides for connection to 115/230vac electrical power for battery charging. Connector is covered by metal plate, attached with two thumb screws when not used. Retaining chain prevents plate from being lost when not in place.

Preceding page blank

Table 2-1 (Cont)

Figure 2-1 Index No.	Control	Function
2.	115/230 VAC Slide Switch	Provides for 115/230 vac line voltage selection.
3.	Meter	Indicates the level of the r-f field in mW/cm^2 as sensed by the probe. (Refer to table 2-3 for proper range/scale ratio for all probes and in the high and low sensitivity ranges.
4.	METER RESPONSE Switch	Provides means of selecting FAST or SLOW meter response.
5.	FREQUENCY Switch	Provides means of selecting either 915 MHz or 2450 MHz frequency.
6.	ZERO Control	Provides for electrical adjustment of meter zero setting.
7.	ALARM Control	Provides means of setting the percentage of full scale meter reading at which the audio alarm will sound to alert the operator of power density greater than the preset level.
8.	RANGE Switch	Provides means of selecting one of the two sensitivity ranges indicated on plug of the probe being used.
9.	PROBE Connector	Provides for connection of Probe plugs.
10.	ON-OFF Power Switch	Provides operating voltage for meter.

Table 2-1 (Cont)

Figure 2-1 Index No.	Control	Function
11.	TEST Switch	Provides means of testing the BATTERY or the PROBE for proper operation.
12.	Alarm	Provides audio alarm to indicate when the preset power density level is exceeded.
13.	RECORDER Jack	Provides for the connection of an external recorder. Provides 100 mV full scale output.
14.	AC Charging Cable	Provides connection to 115/230 vac power for recharging batteries.

2-7. PRE-OPERATION.

2-8. The following pre-operation procedure must be performed before operating the Model 8100 ELECTROMAGNETIC RADIATION SURVEY METER.

a. Review all safety procedures before entering a radiation field.

b. Read all pre-operation and operation procedures before attempting to operate the Survey Meter.

NOTE

All procedures must be followed in the sequence indicated.

c. Connect a probe to the Survey Meter by plugging the probe cable into the Probe Connector.

d. Set the OFF-ON switch to the ON position.

e. Set the TEST switch to the BATTERY position. Observe the meter indication; it should read above the TEST MIN mark on the meter face.

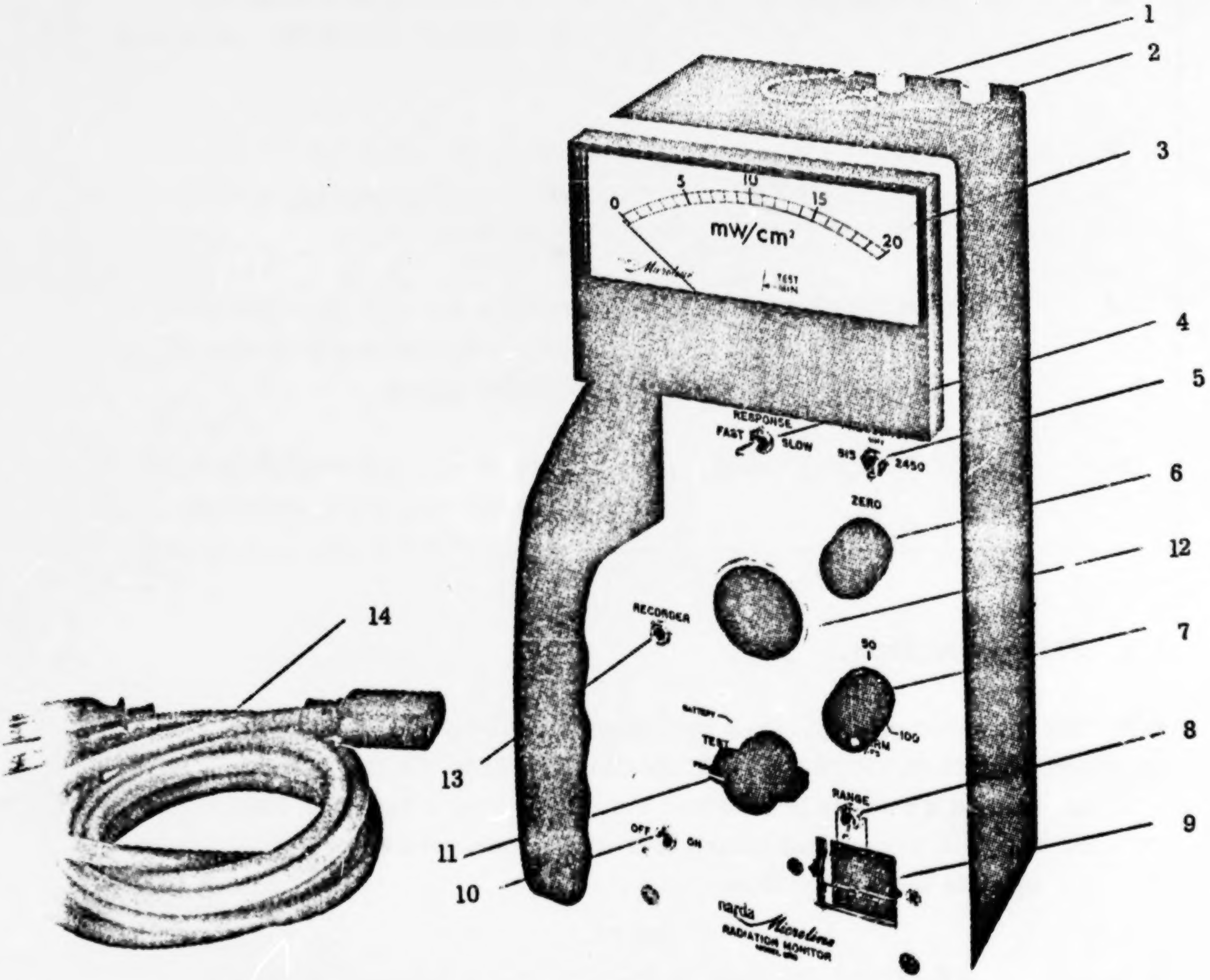
1
2
3
4
5
6
12
7
8
9
14
13
11
10
0
5
10
15
20
mW/cm²
Microline
TEST
MIN
RESPONSE
FAST
SLOW
915
2450
ZERO
RECORDER
BATTERY
TEST
RANGE
OFF
ON
100
narda Microline
RADIATION MONITOR

Figure 2-1. Model 8110 ELECTROMAGNETIC RADIATION SURVEY METER Front Panel Controls and Indicators

f. Set the TEST switch to the PROBE position. Observe the meter indication; it should read above.the TEST MIN mark on the meter face.

NOTE

If the Alarm sounds, the probe is defective.

g. Repeat steps d and f with each probe available.

h. Set the FREQUENCY switch to the desired frequency position. The frequency position is determined by the frequency of the radiation field to be surveyed.

NOTE

When the FREQUENCY switch is in the 915 MHz position, the Model 8130 Antenna Cone must be used with the probe

This photograph not available
at time of publication.

Figure 2-2. Model 8100 ELECTROMATIC RADIATION SURVEY METER Accessories

Table 2-2

Accessory Functional Description

Figure 2-2 Index No.	Accessory		Function
1.	Probe (three probes available refer to table 1-1 for specifications) (Model 8120, 8121 and 8122)	One probe supplied additional probes selected by customer	Provides means of sensing radiation.
2.	915 MHz Antenna Cone (Model 8130)	Supplied	Provides 915 MHz Antenna Element. Provides two inch spacing from the antenna to the tip permitting use at fixed distances from the emanating device.
3.	2450 MHz 2 inch Spacer (Model 8140)	Supplied	Enables the operator to maintain nominal two inches distance from the emanating device throughout his measurement
4.	Zero Power Density Simulator (Model 8150)	Optional	Provides means of shielding probe when zeroing the Survey Meter prior to use.

Table 2-3

Probe Range

Probe	Power Range	Full Scale Power
Model 8120 (Blue)	Low	$0.2\ mW/cm^2$
	High	$2.0\ mW/cm^2$
Model 8121 (White)	Low	$2.0\ mW/cm^2$
	High	$20\ mW/cm^2$
Model 8122 (Red)	Low	$20\ mW/cm^2$
	High	$200\ mW/cm^2$

i. Set the RESPONSE switch to the FAST position.

j. Adjust the ZERO control for a "0" reading on the meter scale.

NOTE

> When zeroing the meter, probe should be placed in a zero density area or pointed toward the floor to avoid stray power density pickup.
>
> If the Model 8150 Zero Power Density Simulator is available, it should be used whenever zeroing the meter.

2-9. PROPER PROBE SELECTION.

2-10. The probe selected must provide greater than 10 percent deflection on the meter to enable accurate and quantitative judgement to be made concerning the actual amount of radiation which is measured.

2-11. If the approximate power density of the field to be measured is not known, use the probe available having the highest power rating.

2-12. If the power density of the field to be measured is known, use the probe available having the Low power range equal to or above the known density; i.e., if the power density is 0.18 mW/cm^2 the Model 8120 (Blue) probe should be used.

2-13. The following procedure specifies the method of determining the proper probe, when surveying ovens or other units with stirrers.

WARNING

> CARE SHOULD BE TAKEN NOT TO PLACE THE EYES IN DIRECT LINE WITH THE SOURCE OF MICROWAVE ENERGY.

a. Connect the appropriate probe, determined in paragraphs 2-10 through 2-12, to the Survey Meter.

b. Set the OFF-ON switch to the ON position.

c. Set the FREQUENCY switch to the desired frequency position. The frequency position is determined by the operating frequency of the unit to be surveyed.

NOTE

When the FREQUENCY switch is in the 915 MHz position the Model 8130 Antenna Cone must be used with the probe.

d. Set the RESPONSE switch to the FAST position.

e. Adjust the ZERO control for a "0" reading on the meter scale.

NOTE

When zeroing the meter the Probe should be placed in a zero density area or pointed toward the floor to avoid stray power density pickup.

If the Model 8150 Zero Power Density Simulator is available, it should be used whenever zeroing the meter.

f. Set the ALARM control to the position at which it is desired to have the alarm sound. (Refer to the published maximum leakage limits accepted by your company for proper alarm setting.)

g. Set the RANGE switch to the Low (left) position.

h. Slowly approach the unit under test from a known safe distance, while facing the probe toward the unit under test and moving it in a circular motion around the suspected area of radiation leakage.

WARNING

ALWAYS START TO MEASURE AN UNKNOWN FIELD FROM AS FAR AS POSSIBLE TO ASSURE SAFETY OF OPERATING PERSONNEL FROM RADIATION.

CAUTION

IF THE ALARM SOUNDS WITHDRAW FROM THE FIELD.

i. If the power density measured causes the alarm to sound; proceed with steps j through p.

j. Back out of the unknown field; and set the RANGE switch to the HIGH power (right) position.

k. Set the ALARM control to the desired position. (Refer to the published maximum leakage limits accepted by your company for proper alarm setting at which it is desired to have the alarm sound.)

l. Slowly approach the unit under test from a known safe distance, while facing the probe toward the unit under test and moving it in a circular motion around the suspected area of radiation leakage.

WARNING

ALWAYS START TO MEASURE AN UNKNOWN FIELD FROM AS FAR AS POSSIBLE TO ASSURE SAFETY OF OPERATING PERSONNEL FROM RADIATION.

CAUTION

IF THE ALARM SOUNDS WITHDRAW FROM THE FIELD.

m. If the power density measured causes the alarm to sound; back out of the field; disconnect the Probe being used; and connect the next higher power rated probe.

n. Repeat steps a through m, until the proper Probe is determined.

2-14. OPERATING PROCEDURE.

2-15. Perform the Pre-operating and the Probe Selection procedures before making any radiation measurements.

WARNING

DO NOT WALK INTO ANY SUSPECTED RADIATION FIELD UNTIL THE SAFE DENSITY LEVEL IS KNOWN.

a. Connect the appropriate probe, determined in paragraphs 2-10 through 2-12, to the Survey Meter.

b. Set the FREQUENCY switch to the desired frequency position. The frequency position is determined by the operating frequency of the unit to be surveyed.

NOTE

When the FREQUENCY switch is in the 915 MHz position the Model 8130 Antenna Cone must be used with the probe.

c. Set the RESPONSE switch to the FAST position.

d. Adjust the ZERO control for a "0" reading on the meter scale.

NOTE

When zeroing the meter, the Probe should be placed in a zero density area or pointed toward the floor to avoid stray power density pickup.

If the Model 8150 Zero Power Density Simulator is available, it should be used whenever zeroing the meter.

e. Set the ALARM control to the desired position. (Refer to the published maximum leakage limits accepted by your company for proper alarm setting at which it is desired to have the alarm sound.)

f. Set the RANGE switch to the Low (left) position.

g. Slowly approach the unit under test from a known safe distance, while facing the probe toward the unit under test and moving it in a circular motion around the suspected area of leakage. Observe the meter reading. If the reading indicated is above the alarm setting, the alarm will sound. Back out of the field until the reading falls below the alarm setting.

WARNING

ALWAYS START TO MEASURE AN UNKNOWN FIELD FROM AS FAR AS POSSIBLE TO ASSURE SAFETY TO OPERATING PERSONNEL FROM RADIATION.

CAUTION

IF THE ALARM SOUNDS, WITHDRAW FROM THE FIELD.

h. Slowly approach the unit under test until the meter indicates the amount of radiation leakage from the unit under test.

WARNING

THE OPERATOR MUST NOT BE EXPOSED TO RADIATION EXCEEDING THE RECOGNIZED SAFETY LIMITS.

2-16. REMOTE OPERATION.

2-17. Radiation measurements can be made without the need for personnel in the suspected radiation field as follows:

a. Perform the procedures specified in paragraphs 2-7 through 2-13.
b. Place the unit under test in a shielded area.
c. Connect the remote or meter recorder to the RECORDER jack on the Survey Meter.
d. Place the Survey Meter in the shielded area with the probe facing the unit under test.
e. Locate the remote meter or recorder outside the radiation envelope.
f. Calibrate the recorder as specified in the manufacturers Technical instructions.
g. Turn the unit under test on and observe the indication on the meter or the operation of recorder.

2-18. AC OPERATION.

2-19. The Survey Meter may be operated from 115-230 volts ac, 50 or 60 Hz, as follows:

a. Remove the metal plate covering the AC Cable Plug Connector and the 115/230 VAC Slide Switch by removing the two thumb screws at the top right hand side of the Survey Meter.
b. Set the 115/230 VAC Slide Switch to the desired position.
c. Connect the Charging Cable provided with the Survey Meter to the AC Cable Plug Connector.
d. Connect the Charging Cable to the AC power Source.
e. Perform the procedures specified in paragraphs 2-7 through 2-15.

CAUTION

CARE MUST BE TAKEN TO ENSURE THAT THE CHARGING CABLE IS KEPT OUTSIDE THE RADIATING FIELD TO AVOID ERRONEOUS READINGS FROM STRAY PICK-UP.

APPENDIX B

INSTRUMENTATION USED FOR THE LABORATORY TESTING OF MICROWAVE OVENS

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INSTRUMENTATION USED FOR THE LABORATORY TESTING OF MICROWAVE OVENS

Meter (8110)		Probe (8121)		Probe (8122)	
#1	01023	#1	01026	#4	01018
#2	02001	#2	02002	#5	02001
#3	02003	#3	02006	#6	02003
#4	02005			#7	02005
				#8	02006

Instrument Set #1

Dipole antenna #1
PRD Thermoelectric Power Meter Model 6685 #296
PRD Thermoelectric Calorimeter Model N-685-2 #243

Instrument Set #2

Ramcor Model 1200B #314

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List of Publications

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	Title	
BRH/DEP 70-8	Development of Liquid Crystal Microwave Power Density Meter (May 1970)	PB 191 396
BRH/DEP 70-9	Product Testing and Evaluation of Giant View® TV Projector (May 1970)	PB 191 906
BRH/DEP 70-10	Survey of Selected Industrial Applications of Microwave Energy (May 1970)	PB 191 394
BRH/DEP 70-11	Leakage Variations from Microwave Ovens (June 1970)	PB 192 042
BRH/DEP 70-12	The Effect of Instrument Averaging Time on Microwave Power Density Measurements (June 1970)	PB 192 322
BRH/DEP 70-13	Variability in the Automatic Processing of Medical X-ray Film (June 1970)	PB 192 702
BRH/DEP 70-14	Simple X-ray Detection Instruments for Television Service Technicians (June 1970)	PB 192 377
BRH/DEP 70-15	A Partial Inventory of Microwave Towers, Broadcasting Transmitters, and Fixed Radars by States and Regions (June 1970)	PB 193 542
BRH/DEP 70-16	Near Field Instrumentation (July 1970)	PB 192 748
BRH/DEP 70-17	Radiation Safety Surveys of X-ray Facilities Within the Federal Health Programs Service (July 1970)	PB 192 957
BRH/DEP 70-18	Bremsstrahlung Production (July 1970)	PB 192 888
BRH/DEP 70-19	Radiation Safety Surveys of X-ray Facilities Within the Bureau of Prisons During 1968 (July 1970)	PB 193 222
BRH/DEP 70-20	Investigation of the Response of the Microlite 287 Probe to Microwave Fields (August 1970)	PB 193 223
BRH/DEP 70-21	Evaluation of an X-radiation Dosimetry Service for Home Television Receivers (August 1970)	PB 193 487
BRH/DEP 70-22	Report of Tests for X-ray Emission from a Rayotron® Electrostatic Generator and Particle Accelerator (August 1970)	PB 193 522
BRH/DEP 70-23	Microwave Oven Test Load Evaluation and Determination of Internal Microwave Energy Distribution	
BRH/DEP 70-24	In-Plant Survey of Television Receivers for X-radiation Emission Capability (September 1970)	
BRH/DEP 70-25	Laboratory Testing and Evaluation of Microwave Ovens (October 1970)	